



**FIELD SAMPLING PLAN**  
**OMC PLANT 2**  
**Waukegan, Illinois**  
**Remedial Investigation/Feasibility Study**  
**WA No. 237-RICO-0528/Contract No. 68-W6-0025**  
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## SECTION 1

# Introduction

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This Field Sampling Plan (FSP) defines the procedures that will be used to perform the Remedial Investigation (RI) at the Outboard Marine Corporation's (OMC) Plant 2 site in accordance with the statement of work for Work Assignment No. 237-RICO-0528.

This FSP consists of the following:

- Section 1 describes the site location, project history and presents a general overview of the RI field activities.
- Section 2 describes the objectives and approach for the sampling program including contaminants of concern and the analytical program.
- Section 3 presents the field investigation program including the field tasks, sampling equipment, and sampling procedures.
- Section 4 provides the general technical guidelines and procedures to be used during the RI. This section also identifies the sample identification, sample custody procedures and quality assurance/quality control (QA/QC) requirements for sample collection, handling and shipping.
- Section 5 provides the references cited in this document that were used to develop the model of existing conditions.
- Appendix A provides analytical tables summarizing the data from the previous investigations.
- Appendix B includes the Field Operating Procedures (FOPs) for performing the sampling tasks, calibrating the equipment, and completing project forms.

## 1.1 Site Setting

The OMC Plant 2 site is situated in Sections 15 and 22, Township 45 North, Range 12 East, Waukegan, Lake County, Illinois. Specifically, the plant is located at 100 E. Seahorse Drive on the east side of Waukegan, immediately adjacent to Lake Michigan<sup>1</sup> (Figure 1-1). The site consists of about 65 acres, upon which are situated a 1,036,000-square foot former manufacturing plant building and several parking lot areas to the north and south of the building complex. The site includes three containment cells in which sediment contaminated with polychlorinated biphenyls (PCBs) dredged from Waukegan Harbor in the early 1990s and PCB-contaminated soils are managed. Two of the cells – the East Containment Cell and the West Containment Cell – are located to the north of Plant 2; the third is located in former harbor Slip 3 south of Seahorse Drive (Figure 1-2). OMC performed the harbor dredging work under a 1988 Consent Decree with U.S. Environmental

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<sup>1</sup> Note: Additional addresses exist due to building extent.

Protection Agency (USEPA) and the Illinois Environmental Protection Agency (IEPA) that also required the long-term operations and maintenance (O&M) of the containment cells.

The site is situated in an area of mixed industrial, recreational and municipal land uses (Figure 1-2). The OMC facility is bordered to the north by the North Ditch and North Shore Sanitary District and to the east by the public beach along Lake Michigan. Sea Horse Drive forms the southern site boundary. Further to the south are Larsen Marine, Waukegan Harbor, the Waukegan Coke Plant Superfund site, the National Gypsum Company, Bombardier, Inc (former OMC Plant 1), and the City of Waukegan Water Plant. Railroad tracks operated by the Elgin, Joliet, and Eastern Railway Company, and the A. L. Hanson Manufacturing Company (formerly OMC Plant 3) are located to the west of Plant 2.

## **1.2 Plant History and Operations**

OMC designed, manufactured, and sold outboard marine engines, parts, and accessories to a worldwide market for many years. Plant 2 was a main manufacturing facility for OMC, and the major production lines used PCB-containing hydraulic and lubricating/cutting oils, chlorinated solvent-containing degreasing equipment, and smaller amounts of hydrofluoric acid, mercury, chromic acid, and other similar chemical compounds.

Plant 2 was constructed in several phases between 1949 and 1975. The western part of the Plant 2 property was purchased from Elgin, Joliet, and Eastern Railway Company in 1948. The easternmost 47 acres of the property was purchased from Abbot Laboratories in 1956. The remaining property was purchased between 1948 and 1956. The 18,000-square foot corporate headquarters building, constructed in 1958, housed OMC's corporate offices (TechLaw 2001).

In December 2000, OMC filed for bankruptcy under Chapter 11 and ceased operations at Plant 2. Bombardier Motor Corporation of America (Bombardier), which owns Plant 1, bought the assets and relocated designated machinery and materials from Plant 2.

### **1.2.1 Description of Manufacturing Operations**

Manufacturing operations at Plant 2 included aluminum smelting and holding; aluminum die casting; aluminum machining, polishing, and finishing; spray painting; assembly; parts washing; chromate conversion coating; and wastewater pretreatment. Activities previously conducted in Plant 2 included vapor degreasing, solvent distillation, coolant reclamation, aluminum scrap processing, and electroplating. The land area occupied by the plant is about 1,036,000 square feet. A basement beneath the wastewater treatment room contains troughs used for chrome plating operations (Tetra Tech 2002).

Numerous floor and strip drains are present in Plant 2, particularly in the former and new die cast areas. Drain systems are present around the die casting machines. When operational, the drains collected and conveyed spent die and machining lubricants to the subslab piping network and eventually to the machining lubricant recovery systems and waste storage areas (TechLaw 2001). Two sets of pipe chases (tunnels) are present beneath Plant 2, one at the eastern end where die casting was most recently conducted, and one at the western end. The eastern pipe chases run north-south and allow access to the subslab piping systems beneath the die casting machines that convey spent die lubricants, tramp oils, noncontact cooling water,

compressed air, and natural gas (TechLaw 2001). The eastern tunnels were observed to be of sound integrity and relatively dry. The piping networks within the western tunnel system were used until about 1975, when the die casting operations were moved to the eastern end of Plant 2. The die casting machines held PCB fluids in the hydraulic sump associated with each machine. Minor amounts of oils containing PCBs were released during operation of the machines. Some of the fluids entered the subslab piping within the concrete tunnels in the western end of the building, contributing to the PCB-contaminated sediment in Waukegan Harbor. The tunnels and associated piping beneath the western end of Plant 2 were never formally decommissioned or decontaminated. However, the north and south sections of storm sewers that extended into the parking lots beyond the limits of the Plant 2 building were decommissioned in 1977 by removing a section of the piping and the soils in the immediate vicinity (URS 2000). Several other drains that had discharged to the North Shore Sanitary District have also been plugged.

#### **1.2.1.1 Transformers**

PCB fluids also were used in numerous transformers located on OMC Plant 2 property. The transformers were located outside, within, and on the roof of OMC Plant 2 (Figure 1-3). The transformers may have leaked fluids during their operation and released PCB fluids to plant drains and outfalls. Table 1-1 is a list of identified OMC Plant 2 transformers.

#### **1.2.1.2 Solvent Degreasers**

Plant records related to past locations of degreasers and tanks indicate that up to 17 degreasers were used in 1979 (Table 1-2). Figure 1-4 depicts the suspected locations for chlorinated solvent handling throughout the history of the plant. In addition to the degreaser units, the facility had a distiller for the purpose of reclaiming solvents and a 5,500-gallon trichloroethylene (TCE) tank housed in a semigrade vault. TCE was distributed to the various degreasers by the use of pipes that were run above ground to each unit. In 1979, prior to an initiative to reduce chlorinated solvent use, it is estimated that OMC used 130,000 gallons of TCE (Willis 1998). The use of chlorinated solvents at the Plant 2 facility stopped in the mid-1980s (Willis 1998).

#### **1.2.1.3 Underground Storage Tanks**

Historically, OMC Plant 2 used roughly 20 underground storage tanks (USTs) during operations (Table 1-3). The USTs were primarily located outside the facility along the building exterior, and they contained oils, lubricants, solvents, #2 fuel oil, and other materials (Figure 1-5).

During the 1970s, OMC installed six 15,000-gallon steel USTs along the east side of Plant 2 (Figure 1-5). Tanks 2.1, 2.2, 2.4, 2.5, and 2.6 were located in an area immediately east of the new die cast facility. Tank 2.3 was located near the southern boundary of the parking area. Table 1-3 summarizes tank designations and contents.

#### **1.2.1.4 Aboveground Storage Tanks**

Aboveground storage tank (AST) investigations have revealed that Plant 2 had numerous ASTs at various locations over the years. Some ASTs and their locations are also listed in Table 1-3 and shown in Figure 1-5. The ASTs were found primarily within the OMC Plant 2 building and contained nitrogen, coolants, soap, oils, lubricants, gasoline, and other materials. The locations of these ASTs are not shown on a figure, as they were routinely moved as plant operations and departments were changed.

## 1.2.2 Operational Permits

The OMC facility operated under a Part B Resource Conservation and Recovery Act (RCRA) permit. The permit identified the Hazardous Waste and Product Storage Building located at the southwest corner of the plant. All hazardous waste were reportedly stored indoors. The RCRA Part B permit did not identify any onsite treatment or disposal activities. Hazardous waste generated by OMC included a gas/oil/water mixture from skimming operations (D001), wastewater treatment sludge (F019/D007), lyfanite filters (D005/D006/D007), aerosol cans (D001), paint wastes (F005), paint sludge (D001/F003/F005), paint filters (F005), and paint thinner MEK (F005), and a number of other specialized waste streams (TechLaw 2001).

Waste pretreatment was also conducted in Plant 2. Pretreatment consisted of hexavalent chrome reduction by sodium bisulfite addition, neutralization, metals precipitation, clarification, pH adjustment, and sludge removal. Wastewater generated from OMC Plant 2 was discharged into two sanitary sewer lines (S-2 and S-2A) tributary to the North Shore Sanitary District (TechLaw 2001).

Stormwater generated by OMC was discharged under a National Pollutant Discharge Elimination System permit. Stormwater discharges include rainwater from the roofs and parking lots, and various sources of noncontact cooling water. Most of OMC's stormwater outfalls (Table 1-4; Figure 1-6) have discharged directly into Waukegan Harbor or Lake Michigan. Historical facility drawings show that several floor drains contained in Plant 2 were also routed through the outfalls (TechLaw 2001).

## 1.3 Previous Investigations and Remediation

The OMC Complex has been subject to investigation and remediation (primarily for PCBs) since the late 1970s. A large body of geologic, hydrogeologic, hydrologic, and chemical distribution information has been developed during these activities and a list of documents obtained is provided in Table 1-5.

### 1.3.1 Waukegan Harbor Remediation

OMC used hydraulic fluid containing PCBs as a lubricant in its aluminum die casting machines from 1961 to 1972. Reports indicate that OMC purchased about 8 million gallons of hydraulic fluid that contained PCBs. During the manufacturing process, some of the hydraulic fluid spilled into floor drains that discharged to an oil interceptor system, which then discharged to the North Ditch, a tributary to Lake Michigan. Some of the hydraulic fluids containing PCBs escaped from part of the oil interceptor, diversion, and pump system and were released directly to Waukegan Harbor in the western end of former Slip 3. The discharge on the northern part of the property was to the Crescent Ditch (Figure 1-6). As a result, large quantities of PCBs were released into Slip 3 and on the OMC property into the North Ditch, Oval Lagoon, Crescent Ditch, and the parking lot. By the time the discharge pipe to the harbor was sealed in 1976, about 300,000 pounds of PCBs had been released into the Waukegan Harbor and another 700,000 pounds to the OMC property. It has also been estimated that hundreds of thousands of pounds of PCBs were discharged into Lake Michigan (USEPA 2002).

The identified areas of concern included former Slip 3 and the northern part of Waukegan Harbor, where large quantities of PCBs were discharged. Sediment PCB concentrations in

former Slip 3 were greater than 500 parts per million (ppm), and PCB concentrations were between 50 and 500 ppm in the North Harbor. The PCB concentrations in Crescent Ditch, Oval Lagoon, and North Ditch ranged from 50 to more than 10,000 ppm. Another area of concern was the 9-acre Parking Lot area north of Plant 2. PCB concentrations there were between 50 and 5,000 ppm.

In 1984, the USEPA selected a remedy consisting of a mixture of onsite containment and offsite disposal that targeted three areas for remediation: the North Harbor and former Slip 3, the OMC parking lot, and the North Ditch/Crescent Ditch/Oval Lagoon area.

Components of the remedy were later modified and embodied in a 1988 Consent Decree. In March 1989, the Record of Decision was correspondingly modified, and the Consent Decree was entered into the U.S. District Court in April 1989. By terms of the Consent Decree, OMC was to finance a trust to implement the cleanup and to ensure performance of the requirements of the Consent Decree. The final remedy included the following (USEPA 2002):

- A new boat slip was built on the east side of the North Harbor on the Waukegan Coke Plant property to replace PCB-contaminated Slip 3. Larsen Marine was relocated from Slip 3 to the new slip.
- A double sheet pile cutoff wall was built to isolate Slip 3 from the North Harbor. A low permeability 3-foot-thick clay slurry wall was anchored 3.5 feet into the underlying clay till, and Slip 3 became a permanent containment cell.
- A total of 8,000 cubic yards of sediment in Slip 3 with PCB concentrations greater than 500 ppm were removed and isolated for treatment. About 30,000 cubic yards of sediment in the North Harbor with PCB concentrations between 50 and 500 ppm were removed and placed in the new Slip 3 containment cell.
- Two other containment cells (termed the East and West Containment Cells) were built with a similar design as the Slip 3 Containment Cell. The East Containment Cell encompasses the Plant 2 Parking Lot area and the land east of the lot. The West Containment Cell encompasses the Crescent Ditch and Oval Lagoon. Before construction, all areas containing PCB contamination at concentrations greater than 10,000 ppm were excavated and removed for treatment. Soils excavated from the Parking Lot area did not require treatment before placement into the East Containment Cell because they did not exceed the treatment criterion. About 5,000 cubic yards of sediment and soil were removed from the North Ditch, 2,900 cubic yards from Oval Lagoon, and 3,800 cubic yards from Crescent Ditch.
- Material removed from designated hotspots was treated by a low-temperature extraction procedure that removed at least 97 percent of the PCBs by mass to separate the PCB oils from the sediments. Residual treated soil was placed in the West Containment Cell, which was then closed and capped. About 30,000 gallons of extracted PCB oil were removed offsite for destruction at a Toxic Substances Control Act (TSCA) approved facility.
- A water treatment plant was constructed and operated to treat water generated during the remedial action.



- An extraction well system was installed and operated at each containment cell to prevent the migration of PCBs from the cells by maintaining an inward hydraulic gradient.

In February 1992, the USEPA completed the sediment remediation project in the harbor that entailed the dredging, thermal treatment, and disposal of PCB-contaminated sediment from the North Harbor. Remediated sediments contained an estimated 1 million pounds of PCBs with a maximum PCB concentration of 500,000 ppm (USEPA 2000). Final construction activities for Operational Unit (OU) #1 and OU #3 were completed in December 1994. Operation and maintenance of the containment cells are ongoing.

### **1.3.2 UST and AST Investigations and Remediation**

Historical operations at the OMC Plant 2 reportedly used about 20 underground storage tanks (Table 1-3). In November 1991, a routine tightness test detected a leak in Tank 2.6. This information was reported to the IEPA, and the incident was assigned number 913462.

In 1993, OMC removed the six USTs and retained Sigma Environmental Services Inc. to perform a closure assessment. Tanks 2.1, 2.2, 2.4, 2.5, and 2.6 were removed from an excavation about 90 feet long, 35 feet wide, and 14 feet deep. Tank 2.3 was removed from an excavation about 35 feet long, 30 feet wide, and 14 feet deep. During removal, groundwater entered the excavations to a level about 3.5 feet below ground.

According to Sigma, Tanks 2.1 through 2.5 were in good condition upon removal. Two small holes were observed in the bottom of Tank 2.6. On the basis of soil staining, strong petroleum odors, and a sheen on groundwater entering the excavation, Sigma concluded that a release had occurred and notified IEPA (Sigma 1993).

In November 1994, Ann Arbor Technical Services Inc. (ATS) conducted an additional investigation to characterize residual soil impacts in the areas surrounding the USTs. During the investigation, 31 soil borings were completed to a depth of 4 feet, and 2 additional borings were completed to a depth of 30 feet. The samples were analyzed for polynuclear aromatic hydrocarbons (PNAs), PCBs, total petroleum hydrocarbons (TPHs), and aryl phosphate esters. PNAs were detected in the 1 to 15 ppm range. PNAs were consistently detected in the 2- to 4-foot depth interval, which is at or below the water table. Based on the reviewed data and the OMC draft internal memorandum, PNAs were not detected in the samples collected from two deeper borings (SB-34 and SB-35) (ATS 1997).

ATS, in their investigation, detected only one PCB compound (Aroclor-1248) in the soil at locations east of the OMC Plant 2 building. Aroclor-1248 was detected at seven locations in the 0- to 2-foot and 2- to 4-foot intervals. Six of the deeper detections occurred at locations where Aroclor-1248 was detected in the shallower sample, whereas one detection occurred at a location without a shallower detection (ATS 1997).

### **1.3.3 Chlorinated Solvent Plume Investigation**

Historic solvent use at OMC Plant 2 resulted in chlorinated hydrocarbon impacts to the groundwater. In the spring of 1997, a subsurface investigation was conducted into the source and extent of chlorinated compounds in the groundwater in the vicinity of Plant 2. Soil and groundwater samples were collected in July 1997, primarily beneath the central part of Plant 2 and extending to the northern and western property boundaries. In

November 1997, an investigation was conducted offsite on the Larsen Marine property south of the OMC corporate building. The investigation focused on the uppermost 30 feet of soil, terminating at the clay till boundary that apparently acts as a confining layer. The findings of the field investigation (Willis 1998) included the following:

- TCE and its daughter products cis-1,2-dichloroethene and vinyl chloride have been identified in groundwater from Plant 2 at concentrations exceeding Illinois Tiered Approach to Corrective Action Objectives Cleanup Objectives for Class I aquifers. Trace amounts of 1,1,1-trichloroethane and 1,1-dichloroethane have also been detected.
- The distribution of chlorinated volatile organic compounds (CVOCs) in the shallow zone of groundwater indicates that one or more source areas are located in the central and northern parts of Plant 2. Those areas correspond to several former vapor degreasers that had operated at the facility. Another potential source area is a cooling pond formerly located in the northwestern corner of the Metal Working Area of Plant 2 (see Figure 1-4). One other area contained TCE in the shallow zone west of the West Containment Cell. That area appears to be a separate source possibly related to underground utilities near or in the former Crescent Ditch.
- Within the deep zone, there is an occurrence of TCE that appears to be unrelated to the suspected source in the center of Plant 2. The area is located in the southwestern corner of the East Containment Cell. The reason for the presence of TCE there is unknown.
- Chlorinated VOCs are distributed throughout the water column.
- Chlorinated VOCs appear to be migrating predominantly to the south and southeast towards Waukegan Harbor. Chlorinated VOC contamination on the eastern part of the site (immediately south of the East Containment Cell) is likely migrating easterly toward Lake Michigan.

### 1.3.4 USEPA Preliminary Assessment and Visual Site Inspection

TechLaw, Inc. conducted a Preliminary Assessment (PA) and Visual Site Inspection (VSI) for USEPA in July 2001. The PA/VSI was performed to identify environmental releases or potential releases from solid waste management units (SWMUs) and areas of concern (AOCs) that may require corrective action by the facility owner. Completion of the PA/VSI fulfills the reporting requirements for implementing corrective action provisions of the 1984 Hazardous and Solid Waste Amendment to RCRA. The description of the 16 SWMUs and 3 AOCs identified for Plant 2 during the PA/VSI are listed in Table 1-6 and shown in Figure 1-7. Table 1-6 also presents the conclusions of the PA/VSI. The former vapor degreasers and still areas (SWMU 4) located in Plant 2 are considered to be potential contributors to at least one large TCE plume identified beneath the western and central parts of the site. Also potential releases associated with the Machining Lubricant Recovery Systems and Waste Storage Areas (SWMU 7), the Plant 2 West End Pipe Chase (AOC A), Leaking PCB-Containing Electrical Equipment (AOC C), and the Stormwater Conveyance System (AOC D) were identified during the VSI (TechLaw 2001).

The potential environmental problems at the OMC Plant 2 by the VSI included:

- PCB-contaminated floors, walls, and ceilings in the old "die cast" building area

- Chlorinated solvents in substantial quantities beneath the building, especially where the self-proclaimed “world’s largest vapor degreaser” was previously located
- A chlorinated solvent groundwater plume potentially migrating into Lake Michigan
- PCB-laden soils beneath the northern parking lot areas (the OU 1 and OU 3 PCB cleanup level was set at 50 ppm)
- Pipe chases leading to the harbor and elsewhere containing oily residue laden with PCBs

In July 2001, USEPA’s Region 5 Waste Pesticides and Toxics Division performed a limited sampling investigation in conjunction with the PA/VSI conducted by TechLaw, Inc. The investigation consisted of sampling (1) water from abandoned pipe chases under the old die cast area and standing water in the pipe chase in the newer die cast area (PCBs), (2) 14 monitoring wells north of Plant 2 (VOCs), (3) stained soil near the railroad spur north of Plant 2 (PCBs), (4) liquid (oil matrix with a layer of water on top) from a cistern/sewer vault near the outdoor chip wringer area on the north side of Plant 2 (PCBs and VOCs), (5) a trough of metal-working fluid (TCLP metals), and (6) residue in the former PCB tank containment area (PCBs) (Lambesis 2001). The results of the investigation indicated:

- The three liquid samples from the pipe chases under the old die cast area all contained detectable concentration of PCB ranging from 21 to 300 µg/L. The water sample from the newer die cast area did not contain detectable concentrations of PCB (detection limit of 0.97 µg/L).
- Groundwater from 11 of the 14 wells sampled contained detectable concentrations of dichloroethane (4.6 to 860 µg/L), dichloroethene (53 to 19,000 µg/L), trichloroethene (280 to 290 µg/L) and vinyl chloride (50 to 5,800 µg/L).
- Two soil samples collected near the railroad spur where there was soil staining contained 15.2 and 18.5 mg/kg of PCB.
- Oil samples from the cisterns contained PCB (18 and 165 µg/L), and the water samples contained dichloroethene (26 to 160,000 µg/L), trichloroethene (2,100 µg/L) and vinyl chloride (210 µg/L).
- The sample of metal-working fluid did not exceed TCLP regulatory levels for metals.
- The solid residue sampled from within the PCB AST containment berms contained 360 µg/kg of PCB.

The USEPA recommended that OMC conduct a RCRA Facility Investigation to determine the extent of these and other contaminated areas and propose a clean-up remedy for the site (Lambesis 2001).

### **1.3.5 USEPA Discovery Site Visit and OMC’s Removal Action**

OMC filed for bankruptcy protection on December 22, 2000, and later abandoned the property after completing a limited removal action under USEPA oversight. In November 2001, the bankruptcy trustee filed a motion to abandon Plant 2.

USEPA conducted a site discovery inspection in Spring 2002 to document the presence of numerous chemical compounds in Plant 2 to support the allegation of imminent and substantial

endangerment. As part of that effort, a site investigation was performed that included the collection of 61 container and miscellaneous samples, two soil, three sediment, four groundwater, 20 suspected asbestos-containing material (ACM), 70 wipe samples from equipment, flooring and office furniture (PCBs), and 14 air samples (five for VOCs and 9 for PCBs). Onsite materials were also inventoried to evaluate potential site-related threats to human health and the environment (Tetra Tech 2002). The analytical results for the samples collected indicated that several areas required attention in terms of waste or product removal and decontamination.

Based on the findings, the USEPA and the State of Illinois filed a joint objection to the abandonment and alleged that the site posed an imminent and substantial endangerment to public health and welfare and the environment. The bankruptcy trustee negotiated an emergency removal action scope of work with USEPA and IEPA that was approved by the court on July 17, 2002. The settlement identified tasks to be completed before the property could be abandoned. The waste removal activities for the OMC Trust were conducted beginning in August 2002 and were completed in November 2002. The completed tasks included removal and disposal of all drums and containers, draining of all tanks, draining and flushing of all transformers, draining and disposal of all hydraulic fluid remaining in machines, draining and disposal of all fluids in the chip wringer and hopper machine, and removal and disposal of all batteries and capacitors. The OMC Trust abandoned the Plant 2 property on December 10, 2002.

Bombardier purchased some assets within Plant 2 that included machines and associated hydraulic fluids, cleaners, and paints. Bombardier removed assets of value, and disposed of waste materials associated with those assets during the OMC Trust's removal activities (Tetra Tech 2003).

### 1.3.6 USEPA Removal Action

USEPA assumed control of building security and utilities on December 10, and planned further removal actions to clean up more of Plant 2. USEPA's activities consisting of waste removal, floor decontamination, site security, operation and maintenance of the three sediment containment cells, tunnel inspections, soil and groundwater sampling, asbestos removal, and draining and disposal of PCB-contaminated transformer fluid commenced on May 12 and concluded on July 11, 2003. Wastes removed included hydraulic oil, machining oil, oily metal chips, sludge, compressed gasses, and waste decontamination water. Samples collected during the discovery site visit and PRP removal activities in 2002 indicated several areas requiring decontamination. The chip wringer pit, metal working floor, former parts storage area floor, and floor in the old die cast area were cleaned. Floor decontamination efforts reduced PCB concentrations on the floors, but remaining concentrations exceed standards in five of nine metal working area wipe samples collected following floor cleaning (Tetra Tech 2003).

Additional decontamination included cleaning the former baghouse. All baghouse dust was collected, sampled for TCLP metals, found to be nonhazardous, and disposed of as nonhazardous special waste. Compacted wet metal fines were removed from the deburring pit using a small excavator, and placed into a lined rolloff box for disposal as nonhazardous waste. A red tanker truck parked behind Plant 2 was found to contain several inches of PCB sludge. The tanker was cleaned, and holes were cut in the bottom to prevent future use.

Tunnels beneath the old die cast area were inspected to determine if they could release contaminants to the environment. No gross contamination was observed, but 2 capacitors containing PCB oils, 2 compressed gas cylinders containing oxygen and acetylene, and a 20-gallon steel drum containing PCB oils were removed from the tunnels. Samples of water in the tunnels indicated only low-levels of PCBs (Tetra Tech 2003).

Limited soil and groundwater sampling were conducted during USEPA removal activities to provide current information on subsurface conditions. Soil samples were collected using direct push methods, and water samples were collected from temporary monitoring points and existing monitoring wells. Elevated levels of PCBs and TPH were detected in a soil sample collected north of Plant 2 next to the chip wringer room. Elevated PCB concentrations were also detected in soil samples collected from north of the former chip dock in the old die cast area, and from near the former concrete containment for the former PCB oil ASTs. Elevated concentrations of VOCs, generally TCE and daughter products, were detected in soil samples collected south of the building outside where parts degreasing was performed, outside the chip wringer room, outside the paint spray room, and at the former vapor degreasing location (Tetra Tech 2003).

Groundwater samples were collected in June 2003 from 23 locations. Elevated VOC concentrations were detected in eight locations (MW-15S, GP-12, MW-T106, GP-8, GP-5, GP-4, and GP-15). The most frequently detected VOCs were TCE and related daughter products (Tetra Tech 2003).

Friable ACM was identified on three pressure vessels in the north boiler room and was targeted for removal. ACM associated with venting and external piping in the western part of the plant also was removed. No sampling or analysis of the ACM was conducted (Tetra Tech 2003).

A geophysical survey using ground-penetrating radar was conducted based on historical plant drawings to verify the existence of USTs on the property. Subsurface anomalies consistent with USTs were detected in areas outside the old die cast area and inside the chip dock on the north side of the building. Based on historical drawings, the tanks outside the old die cast area contained fuel oil and reportedly were abandoned in-place and filled with inert material, such as sand or concrete. The USTs in the chip dock area reportedly were used to hold new and used hydraulic oil from die cast operations (Tetra Tech 2003).

Air samples for PCBs were collected from the western part of the building, including the old die cast area, the former parts storage area, and the metal working area. Analytical results indicated PCB concentrations exceeding the NIOSH time-weighted average exposure limit of 1 µg/m<sup>3</sup> (Tetra Tech 2003).

Electrical transformers located on the roof and inside Plant 2 were drained in July 2003. Transformers had previously been drained and re-filled during removal activities conducted by the OMC Trust in 2002. After 90 days of use USEPA sampled the transformers and found that PCB concentrations still exceeded regulatory limits. After each transformer was drained in 2003, the plugs were replaced and the transformer was left empty with the power disconnected. However, transformer #8 was left full of fluid and energized because it was determined that the transformer supplied the Plant 2 guard house, phone, and fire alarm systems with power.

## 1.4 Geologic and Hydrogeologic Setting

The geologic and hydrogeologic setting presented below are discussed in terms of regional conditions and those encountered during investigations at the site.

### 1.4.1 Geology

The geology beneath the site is characterized by near-surface fill materials that were placed over a fine-grained sand unit. The sand overlies an 80-foot-thick till unit, which overlies a sequence of dolomitic bedrock formations. At the site, the fill deposits extend to 2 to 12 feet below ground surface. The fill typically consists of reworked sand deposits with wood fragments and other debris. The fill was typically used to build up the low areas for development.

The naturally occurring material underlying the fill consists of fine-grained sand with gravel to a depth of about 25 to 30 feet. These materials are part of the Equality Formation that were deposited as beach sands along the shore of former glacial Lake Chicago. The unit consists of a well-sorted fine to very fine sand containing 5 to 15 percent silt. Deeper portions of the sand unit typically show finer grain sizes than shallow portions. Measured porosity values of the sand unit range from 33 to 41 percent.

Underlying the Equality Formation is the Wadsworth Till of the Wendron Formation. Beneath the site, the till extends to a depth of about 100 feet and consists of a hard, gray, lean clay with sand and some gravel. The till's surface is overlain by a thin discontinuous zone of silty gravel or gravel with sand, which, where present, has an average thickness of 0.3 foot. The surface of the till is irregular, and generally slopes gently downward from west to east beneath the peninsula (USEPA 1999). The contour map of the till surface presented in Figure 1-8 was generated based on information from soil and monitoring well boring data and cone penetrometer testing. Roughly 10 feet of vertical drop in the till occurs across the site from west to east. A series of depressions in the till surface trend north-south near the middle of Plant 2. In situ permeability tests of the till indicate a horizontal and vertical coefficient of permeability at approximately  $10^{-7}$  cm/sec (Canonie 1991).

Silurian age dolomite comprises the uppermost bedrock in the area. This shallow bedrock is fractured and contributes to groundwater flow in the Silurian dolomite. Underlying the Silurian dolomite are the Maquoketa Group shales that act as an aquitard, separating the Silurian dolomites from the deeper bedrock units.

### 1.4.2 Hydrogeology

Previous investigations encountered groundwater under unconfined conditions at about 2 to 5 feet below ground surface. This depth is heavily influenced by the surface water elevations present in Lake Michigan and the Waukegan Harbor. The underlying till unit forms the lower boundary of this unconfined aquifer and likely acts as a barrier to the vertical contaminant migration.

Groundwater level measurements from August 1997 and February 1998 were used to construct the groundwater contour maps presented in Figures 1-9 and 1-10, respectively. Groundwater elevations indicate primary flow to Lake Michigan, Waukegan Harbor, and North Ditch areas. A groundwater ridge also occurs along the central part of OMC Plant 2

for both events. Vertical gradients are generally downward except for near-surface upward gradients along the North Ditch area.

The site, surrounding properties, and the City of Waukegan obtain potable water from Lake Michigan. The city has no municipal potable wells. There are some private residential wells within the city limits at a distance from the site (URS 2000).

## 1.5 Chemical Characteristics

Several investigations have been conducted to evaluate the impacts of OMC Plant 2 on the surrounding environment. These investigations were conducted to either address specific concerns (e.g., USTs or the chlorinated VOC plume) or were limited in scope and do not individually provide a comprehensive model of the nature and extent of contamination. In order to take advantage of the existing data, a site-specific database was developed that analytical data from 1996 to the present. The documents that were used to create the database are presented on Table 1-5 and summary data tables developed from the laboratory reports are provided in Appendix A.

Based on OMC's historical chemical use and operational practices, the extent of contamination, provided the data are available, were evaluated based on the following chemical groups:

- Total CVOCs—the sum total of detected concentrations of 1,1,1-trichloroethane, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, cis-1,2-dichloroethene, trans-1,2-dichloroethene, TCE, tetrachloroethene, vinyl chloride, and chloroethane. The presence of these compounds would be indicative of the impacts related to solvent use at the plant.
- Total BETX—the sum total of detected concentrations of benzene, ethylbenzene, toluene and total xylenes. The presence of these compounds would be indicative of potential impacts from petroleum hydrocarbons (e.g., gasoline and oils).
- Total CPAHs—the sum total of detected concentrations of carcinogenic polynuclear aromatic hydrocarbons including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The presence of these compounds would be indicative of heavier-end petroleum products (e.g., hydraulic oils, fuel oil).
- Total PCBs—the sum total of detected concentrations of the different PCB aroclors.

The nature and extent of contamination within the building, soil and sediment, and groundwater or surface water are discussed below.

### 1.5.1 Plant 2 Sampling

Wipe and air samples within Plant 2 were collected by USEPA during the discovery site visit and the removal action. The sampling methodology and results of the sampling conducted in Plant 2 are discussed in the *Discovery Site Visit Report* (Tetra Tech 2002) and the *USEPA Removal Action Summary Report* (Tetra Tech 2003). Tables summarizing the analytical results are also provided in Appendix A.

### 1.5.1.1 PCB Wipe Samples

A total of 70 wipe samples were collected in March 2002 from equipment (19 samples), flooring (48 samples), and office furniture (3 samples). The samples were only analyzed for PCBs. All of the wipe samples except for three contained detectable concentrations of Aroclor 1248 (Tetra Tech 2002). A summary of the wipe samples by type of surface is presented in Table 1-7.

The results of the wipe samples collected during the site visit indicated that several plant areas warranted decontamination. In March 2003, 28 floor wipe samples were collected from the metal working areas to delineate the area of floor to be cleaned. Decontamination activities were conducted on the floor in the metal working area (about 36,000 square feet), the old die cast area (20,000 square feet), and the parts storage areas (12,000 square feet). Fifteen wipe samples were collected from the cleaned floor areas and the main aisle over which the machines were transported and loaded for disposal. A summary of the results for pre- and post-decontamination are presented in Table 1-8. The PCB wipe samples results for the floor areas that were not decontaminated and post-decontamination floor samples are shown on Figure 1-11. The floor decontamination efforts appear to have reduced the PCB concentrations on the floor, but the remaining concentrations persist in most of the areas (Tetra Tech 2003).

### 1.5.1.2 Air Sampling

Five VOC and nine PCB samples were collected in March 2002 from various areas within Plant 2. Several VOCs were detected in the air samples; however, none of the concentrations exceeded their respective National Institute of Occupational Safety and Health (NIOSH) time-weighted average (TWA) limits. Detected VOCs included cis-1,2-dichloroethene (0.32 to 1.8 ppb), methylene chloride (0.25 to 21 ppb); 1,1,1-trichloroethane (0.32 to 29 ppb), TCE (0.59 to 3.3 ppb) and toluene (20 ppb), ethylbenzene (0.31 to 1.7 ppb), and xylenes (1.57 to 7.3 ppb). Aroclor-1242 was detected in all of the samples except for the two samples collected from the east end of the building in the new die cast area. Detected Aroclor 1242 concentrations ranged from 0.21 to 1.7  $\mu\text{g}/\text{m}^3$ . Two of the samples, one from the west end of Plant 2 in an office area (1.7  $\mu\text{g}/\text{m}^3$ ) and the other from western edge of the metal working area (1.2  $\mu\text{g}/\text{m}^3$ ) contained concentrations exceeding the NIOSH TWA exposure limit for Aroclor 1242 of 1  $\mu\text{g}/\text{m}^3$  (Tetra Tech 2002).

Air sampling was also conducted in the plant building during USEPA's removal activities in 2003 to determine the disposition of airborne PCBs after decontamination activities were completed. Air samples were collected from the western portion of the building, from the old die cast area, the former parts storage area, and the metal working area. Similar to the previous results, Aroclor 1242 was the only PCB detected and was found in the four samples. Aroclor concentrations ranged from 4.2 to 18  $\mu\text{g}/\text{m}^3$  with higher concentrations detected in the old die cast area and lower concentrations in the metal working area. The concentrations exceed the NIOSH TWA limit of 1  $\mu\text{g}/\text{m}^3$  (Tetra Tech 2003).

## 1.5.2 Soil and Sediment

The majority of the soil sampling conducted at the site was to characterize the residual soil contamination related to former Die Cast USTs that were located along the east wall of the plant (see Figure 1-5). Soil samples collected as part of the closure assessment from each excavation indicated BETX and PCB contamination, while water samples indicated BETX,



PAH, and PCB contamination (Triad Engineering, 1996). A residual soil investigation was conducted in November 1994 that included collecting and analyzing 71 soil samples from 35 locations. Most locations were sampled to a depth of 4 feet (i.e., the vadose zone); however, two deep borings were completed to the till layer at a depth of about 32 feet. Based on visual observations and organic vapor readings, six soil samples were selected for rapid response screening analysis to determine the suite of contaminants present. The six rapid response samples were analyzed for VOCs, semi-volatile organic compounds (SVOCs) including CPAHs, pesticide, PCBs and ester extractables, and total petroleum hydrocarbons (TPH). Because only one sample contained detectable concentrations of VOCs, the remaining samples were analyzed for SVOCs, PCBs and aryl phosphate esters (APEs), and TPH (ATS 1997).

Based on the potential for transformer fluid leaks on the roof of Plant 2 to discharge through Outfall 007 into an unlined swale and eventually into Lake Michigan, an assessment was conducted by the Illinois Department of Natural Resources (IDNR) in 2001. The purpose of the assessment was to identify if PCB concentrations were present in the swale of Outfall 007 or in the lake sediment as a result of the transformer fluid release. The Outfall 007 investigation included the collection of two surface soil and two sediment samples along the run of Outfall 007. In addition, two of the lake-bottom samples were taken directly east of Outfall 007 (CDM 2001).

Additional soil and sediment samples were collected during USEPA's discovery site visit and removal action. The site visit activities in March 2002 included collecting composite soil samples from near the hopper outside of the chip wringer room (SS-01) and another from the former PCB AST area (SS-02). In addition, sediment samples were collected from three locations about two feet from shore within the North Ditch. Soil and sediment samples were collected from 0 to 12 inches bgs and were analyzed for PCBs and VOCs. One of the soil samples collected near the hopper outside of the chip wringer room (SS-01) was also analyzed for RCRA metals (Tetra Tech 2002).

USEPA also conducted limited soil sampling during the removal action in June 2003. The sampling was conducted to determine if a source or sources of PCB or chlorinated solvents could be located around Plant 2 and to gather current information about site conditions. Soil samples were collected from 15 locations outside of Plant 2 using direct push technology. Samples collected from shallow depths were generally analyzed for oils and PCBs, and deep samples were analyzed for VOCs (Tetra Tech 2003).

#### **1.5.2.1 CVOCs**

The distribution of CVOCs in the surface soil (< 2 feet deep) and sediment, shallow soils (2 to 4 feet deep) and subsurface soil (greater than 4 feet deep) across the site are presented in Figures 1-12, 1-13 and 1-14, respectively. The limited data indicate that the surface soils and sediment are not impacted by CVOC compounds. The sediment sample from the east end of the North Ditch was the only sample containing detectable concentrations of CVOCs (42.3 µg/kg of cis-1,2-dichloroethene).

Elevated concentrations of CVOCs, mainly TCE and cis-1,2-dichloroethene, were detected in most of the shallow (5 of 10 samples) and subsurface (5 of 7 samples) soil samples. The highest concentrations of total detected CVOCs were found at depth in the vicinity of the former solvent degreasers, the chip wringer room, and near former USTs (Figures 1-13 and 1-14).

The potential source areas, as indicated by high TCE concentrations, are associated with former solvent degreasers and the product storage outside of the chip wringer room. TCE concentrations detected in the shallow and subsurface soils ranged from 7.03 to 268,000 µg/kg. Generalizations of TCE concentration with of depth cannot be made based on the limited data available. The TCE results for locations with samples collected at multiple depths are shown in Table 1-9.

#### 1.5.2.2 BETX

The distribution of BETX compounds in the soil and sediment are presented in Figures 1-15, 1-16 and 1-17. Similar to the distribution and occurrence of CVOCs, the surface soils do not appear to be impacted by BETX compounds. None of the six surface soil or three sediment samples contained detectable concentrations of the BETX compounds (Figure 1-15).

Low levels of BETX compounds were detected in the shallow and subsurface soil with maximum concentrations of 86.79 µg/kg and 36.4 µg/kg, respectively. The maximum concentrations were both from boring GP-8 outside of the chip wringer room (Figures 1-16 and 1-17). With the exception of the sample from GP-2, the results are consistent with the locations of former UST areas or loading areas. The sample from the 3- to 4-foot interval from GP-2 located northeast of the chemical storage building contained the second highest total BETX concentration of 25.74 µg/kg (8.74 µg/kg of benzene and 17 µg/kg of toluene) (see Figure 1-16). There is no information indicating what the potential source of BETX compounds would be in this area.

#### 1.5.2.3 CPAHs

Soil samples analyzed for CPAHs were limited to the former USTs on the east side of the plant that were collected to assess the extent of residual soil contamination related to the tanks (Figures 1-18, 1-19, and 1-20). The analytical results are relatively consistent with the excavation and removal of contaminated soils during the removal of the USTs. The surface soil results indicate that the occurrence of detectable concentrations of CPAH compounds in the residual soil is limited and generally well bounded. Seven of the 35 surface soil samples contained detectable concentrations of CPAH compounds with total concentrations ranging from 300 to 49,000 µg/kg. The majority and the highest concentrations of the detected compounds were from samples collected between the two tank areas. Low levels of CPAHs in SB-16-94 (300 µg/kg), PLS2SB02-98 (687 µg/kg), and PL2SB01-98 (3,027 µg/kg) indicate that lateral extent of the CPAHs may extend further to the east between the two tank areas (Figure 1-18).

Based on the analytical results from the 33 shallow and 5 subsurface soil samples, the residual contamination identified in the surface soils do not extend vertically (i.e., beyond the 0- to 2-foot depth interval). Shallow soil samples collected from beneath five of the surface soil locations with detectable concentrations of CPAHs did not contain CPAHS (Figures 1-19 and 1-20). Although only 3 of the 33 shallow soil samples contained detectable concentrations of CPAHs, the distribution of these samples indicates that the lateral limits of the CPAHs to the east of the former tank area are not well defined. Total CPAH concentrations ranging from 300 to 75,000 µg/kg were found in three of the soil borings (SB-21-94, SB-19-94 and SB-33-94) that comprise the eastern sampling boundary (Figure 1-19).

#### 1.5.2.4 PCBs

The majority of the soil samples collected and analyzed for PCBs were to characterize the residual soil impacts in areas surrounding the former Die Cast USTs east of the plant. Relatively few samples were collected from other areas surrounding the plant. During USEPA's sampling activities, a few samples were collected to evaluate the PCB concentrations in residual soils around other former UST and AST locations and sediment in the North Ditch (Figures 1-21, 1-22, and 1-23). The USEPA sampling included two composite surface soil samples and three sediment samples from North Ditch (Figure 1-21). PCBs were detected in all five of these surface soil or sediment samples. The soil samples contained PCB Aroclor 1248 concentrations of 2,990 and 18,400 µg/kg. Two sediment samples contained 1,890 and 1,360 µg/kg of Aroclor 1242 and the third sediment sample contained 8,530 µg/kg of Aroclor 1248. The PCB results for surface soil samples east of the plant are presented in Figure 1-21.1. The analytical results indicate that elevated PCB concentrations remain in the surface soil and in the swale along Outfall 007. Of the 36 surface soil and two sediment samples only three samples did not contain detectable concentrations of PCBs and six additional samples contained total PCB concentrations of less than the 1,000 µg/kg. The 1,000 µg/kg (1 ppm) concentration is the Illinois Tiered Approach to Corrective Action Objectives (TACO) Tier 1 limit for PCBs in soil based on a direct contact exposure route (35 Illinois Administrative Code 742.510). The data also indicate that the lateral extent of the elevated PCB concentrations in the surface soil has not been defined (Figure 1-21.1). In addition, low concentrations of PCBs (total PCB concentrations of 2,43.5 to 1,000.5 µg/kg) were also detected in the four samples collected along Outfall 007. PCB levels decreased with respect to distance from the potential source (i.e., transformer leaks on the roof) along the swale toward Lake Michigan (Figure 1-21.1). PCBs were not detected in the two lake-bottom sediments samples collected east of Outfall 007.

Similar to the distribution of surface soil samples, the number of shallow soil samples is limited outside of the former UST area east of the plant. Five shallow soil samples and no subsurface soil samples were collected from around other former UST and AST locations (Figure 1-22 and 1-23). The limited shallow soil data indicate PCB concentrations appear to decrease with depth. However, elevated concentrations of PCB may exist in the beneath other areas of the site. The highest total PCB concentration was detected near the chip wringer room (7,170 µg/kg). The PCB data from residual shallow and subsurface soils surrounding the former UST area east of the plant are presented in Figures 1-22.1 and 1-23, respectively. Detected total PCB concentrations in this area were between 100 and 120,000 µg/kg in the shallow soil samples and from 1,700 to 8,900 µg/kg in the subsurface soil samples.

#### 1.5.3 Groundwater and Surface Water

The existing condition of groundwater quality at the site was evaluated both laterally and vertically. The analytical data allowed the aquifer to be divided into three vertical zones. The shallow zone data includes groundwater results from the water table surface to a depth of about 10 feet. The deep zone data includes the groundwater results above the till surface (20 to 30 feet deep) and the intermediate zone lies in the middle (10 to 20 feet).

### 1.5.3.1 CVOCs

VOC results obtained during sampling events related to both the Waukegan Harbor project and the NPDS discharge sampling identified chlorinated compounds in groundwater beneath the site. The results of the sampling conducted in 1995, 1996 and 1997 indicated that TCE and its dechlorination products were the principle CVOCs identified at Plant 2. TCE was historically used in Plant 2 degreasing operations until 1979 when OMC implemented an initiative to reduce the use of chlorinated solvents.

The distribution of CVOCs in the shallow, intermediate and deep zones are presented in Figures 1-24, 1-25, and 1-26, respectively.

**Shallow Zone.** CVOCs were detected in 23 of the 53 shallow zone groundwater samples with total CVOC concentrations ranging from 4.03 to 20,632.6 µg/L (Figure 1-24). The distribution of CVOCs in the shallow zone appears to indicate potentially three CVOC source areas. The major portion of the CVOCs plume appears to be located around the central portion of the plant with a north-south trend. This distribution is consistent with the areas with high CVOC concentrations in the soil corresponding to the locations of former solvent degreasers. The second area is in the vicinity of the former UST area near the chip dock in the northwestern portion of the plant. Total CVOC concentrations of 1967.1 and 24.64 µg/L, consisting of mainly of TCE degradation compounds, were detected in GP-4 and GP-5, respectively. The soils data in this area also indicated the presence of CVOCs at elevated concentrations. The shallow soil samples from GP-4 and GP-5 contained total CVOC concentrations of 863.6 and 57.34 µg/kg, respectively. The remaining area with elevated CVOC concentrations in the shallow zone was in the southeastern corner of the plant. The CVOC concentrations in this area were lower than the other plume areas with total CVOC concentrations of 3.59 µg/L in HY-UST2 and 29.88 µg/L in MW-15 (Figure 1-24). There were no indications of CVOC soil contamination in this area.

**Intermediate Zone.** CVOCs were detected in 28 of the 50 intermediate zone groundwater samples with total CVOC concentrations ranging from 35.1 to 48,426.1 µg/L (Figure 1-25). The distribution of the CVOCs in the intermediate zone has expanded to the north and south compared with that found in the shallow zone. The highest concentrations of CVOCs were found in the same areas associated with the solvent degreasers and TCE UST formerly located in the central portion of the plant. In the northwestern portion of the site, elevated CVOC concentrations were detected in the monitoring wells around the West Containment Cell. There are no shallow wells or soil samples in this area to determine if this is an additional source area or just an extension of the central area plume. The distribution of CVOCs in the intermediate zone appears slight larger to the south extending across Seahorse Drive beneath Larsen Marine with 165 and 2,040 µg/L of 1,2-dichloroethene detected in HY-30 and HY-31, respectively (Figure 1-25). An isolated occurrence of CVOCs (7145.8 µg/L in W-06) was also detected near the southwestern corner of the East Containment Cell. Monitoring well W-6 is screened from 15 to 27 feet and the data for this well is included in maps both intermediate and deep zones.

**Deep Zone.** CVOCs were also detected in 39 of the 70 deep zone groundwater samples with total CVOc concentrations ranging from 2 to 57,568.4 µg/L (Figure 1-26). The distribution of CVOcs is relatively consistent with the upper portions of the aquifer with high concentrations in the central plant area and around the West Containment Cell. High concentrations of CVOcs, mainly degradation products, were also detected around the southwest and eastern corners of the East Containment Cell (total CVOc concentrations of 7145.8 µg/L in W-06 and 34,906 µg/L in W-05, respectively).

#### **1.5.3.2 BETX**

The distribution of BETX in the shallow, intermediate and deep zones are presented in Figures 1-27, 1-28, and 1-29, respectively. The data indicate that BETX as a group do not significantly impact groundwater quality. The occurrence of detectable concentrations of BETX compounds appear to be isolated and limited. In the shallow zone, low levels of BETX were detected at two locations adjacent to former UST areas. The total BETX concentrations detected were 2.77 µg/L (toluene) in GP-08, located near the chip wringer room, and 77.1 µg/L (benzene 75 µg/L and toluene 2.1 µg/L) in HY-UST2, located in the southeastern corner of the site.

Low levels of BETX were also detected at two locations in the intermediate and one in the deep zone (Figures 1-28 and 1-29). In the intermediate zone, the groundwater sample from the monitoring well on the northeast corner of the West Containment Cell (W-12) contained 8 µg/L of benzene and another sample from the southeastern corner of the site (VP-01) contained 1.3 µg/L of benzene. Monitoring well W-12 is screened from 10 to 25 feet and is included in both intermediate and deep zones. Benzene was also detected at a concentration of 12.7 µg/L in W-4C located near the North Ditch between the two containment cells.

#### **1.5.3.3 CPAHs**

The majority of groundwater data collected for Plant 2 focused on the investigating the nature and extent of VOCs, mainly the chlorinated solvent plume or the potential groundwater impacts from former USTs. Only limited groundwater samples have been analyzed for CPAHs and PCBs. The CPAH data consist of results from groundwater samples collected from temporary piezometers or drive points in the shallow (three locations) and intermediate (one location) zones. CPAHs were detected in two of the shallow zone groundwater samples (total CPAH concentrations of 2.39 and 0.18 µg/L). Individual CPAH concentrations were all less than 1 µg/L.

#### **1.5.3.4 PCBs**

Groundwater samples from three monitoring wells in the intermediate zone and four monitoring wells in the deep zone were analyzed for PCBs. PCBs were only detected in one of the groundwater samples. A total PCB concentration of 6.54 µg/L was detected in the deep zone well (W-6) located adjacent to the southwestern corner of the East Containment Cell. This well also contained elevated concentrations of CVOcs (total PCB concentration of 55,261 µg/L).

## **1.6 Overview of the Remedial Investigation**

The field investigation was designed to verify impacts of historical facility operations on the surface soil and sediment, subsurface soils and groundwater environmental media. The

specific investigation objectives were developed based on observations during the site visits, available information on past activities and suspected source areas, and available soil and groundwater analytical data. The general objectives for the remedial investigation are to:

- Define the nature and extent of contamination in the plant to assess if residual contamination in the building material poses potential risks to human health and/or whether it may affect future remedial (disposal) options for the building.
- Define the nature and extent of the contamination in surface soil and sediment and subsurface soil and groundwater to support the assessment of potential risks to human health and the environment and to determine whether remedial actions are necessary.
- Determine if volatilization from the underlying groundwater plume south of the site may cause a potential inhalation risk to human health.
- Determine whether nonaqueous phase liquids (NAPLs) are present beneath the identified potential source areas (e.g., former solvent handling areas, processing rooms, aboveground and underground storage tanks, and loading docks), such that remedial action alternatives can be evaluated.
- Collect the site-specific geologic and hydrogeologic information necessary to evaluate the risk and remedial action alternatives.

The specific sampling objectives and data collection rationale and methodologies for the different media are discussed in detail in the following sections.

**TABLE 1-1**  
Description of Transformers Identified for Plant 2  
OMC Plant 2

Transformer Number	Location	Transformer Insulation	Capacity (gal)	Weight of PCBs (kg)	PCB Concentration <sup>a</sup> (mg/kg)
1	Plant #2—Outside	M2-Oil	1,389	0	NS <sup>b</sup>
2	Plant #2—Inside	Askarel	290	1,142.6	28,000
3	Plant #2—Inside	Askarel	520	2,048.8	NS
4	Plant #2—Inside	Askarel	513	2,021.2	NS
5	Plant #2—Inside	Askarel	392	1,544.5	32,000
6	Plant #2—Inside	Askarel	392	1,544.5	16,000
7	Plant #2—Inside	Askarel	290	1,142.6	42,000
7B	Plant #2—Roof	Chlorextol	359	1,414.5	59,000
8	Plant #2—Inside	Askarel	392	1,544.5	34,000
8B	Plant #2—Roof	Chlorextol	434	1,710	9,600 J
9	Plant #2—Inside	Pyranol	205	807.7	53,000
10	Corp. Penthouse	Askarel	510 (71) <sup>c</sup>	2,009.4	— <sup>b</sup>
11	Plant #2—Inside	Askarel	400	1,576	44,000
12	Plant #2—Roof	C <sub>4</sub> F <sub>8</sub>	Dry <sup>a</sup>	0	NS <sup>b</sup>
13	Plant #2—Roof	Pyranol	240 (320) <sup>c</sup>	945.6	— <sup>b</sup>
14	Smelter Roof	Inerteen	293	1,154.4	27,000
15	Smelter Roof	Inerteen	293	1,154.4	27,000
16	Smelter Roof	Inerteen	317	1,249	NS
17	Smelter Roof	Inerteen	293	1,154.4	25,000
18	Die Cast Roof	Inerteen	293	1,154.4	29,000
19	Die Cast Roof	Inerteen	293	1,154.4	47,000
20	Die Cast Roof	Inerteen	293	1,154.4	30,000
22	Die Cast Roof	Inerteen	293	1,154.4	NS
23	Die Cast Roof	Inerteen	293	1,154.4	48,000
26	Die Cast Roof	Inerteen	293	1,154.4	27,000
27	Die Cast Roof	Inerteen	293	1,154.4	52,000
28	Die Cast Roof	Inerteen	293	1,154.4	48,000
30	Die Cast Roof	Inerteen	293	1,154.4	34,000
31	Die Cast Roof	Inerteen	293	1,154.4	38,000
32	Die Cast Roof	Inerteen	293	1,154.4	25,000

**TABLE 1-1**  
Description of Transformers Identified for Plant 2  
OMC Plant 2

Transformer Number	Location	Transformer Insulation	Capacity (gal)	Weight of PCBs (kg)	PCB Concentration <sup>a</sup> (mg/kg)
34	Trim Building Roof	Inerteen	293	1,154.4	35,000
TR72	Outside—owned by Commonwealth Edison	Oil <sup>b</sup>	6441	0	NS
TR73	Outside—owned by Commonwealth Edison	Oil <sup>b</sup>	6441	0	NS

Notes:

<sup>a</sup> PCB concentrations were from sampling conducted on March 26, 2003 during USEPA removal activity. 40 CFR Part 761 regulatory standard of 50 ppm was used for comparison. Transformers, except for #8 were drained and left empty.

<sup>b</sup> This transformer contained non-polychlorinated biphenyl fluid.

<sup>c</sup> Transformer capacity varied based on source. The latter capacity value in parenthesis was taken from Tetra Tech EM, Inc., 2003.

NS = Not sampled

J = The analyte was detected. The reported numerical value is considered estimated for QC reasons.

Sources: OMC. n.d. *In-Service Transformer Inventory*.

Tetra Tech EM, Inc. 2003. *EPA Removal Action Summary Report*.



**TABLE 1-2**  
Description of Degreasers Identified for Plant 2  
OMC Plant 2

Degreaser ID	Removed from Service/Retrofit	Plant 2 Department Number
JM3776	Degreaser removed in 1980	201
JM5743	Degreaser retrofit in 1981	201
JM1951	Degreaser removed in 1980	241
JM3477	Degreaser removed in 1980	248
JM3353	Degreaser removed in 1981	248
JM6361	Degreaser retrofit in 1981	248
JM5310	Degreaser removed from R.C. Engine dept. 255 in 1980 Retrofit before being moved to dept. 248 in 1981	255/248
JM4838	Degreaser retrofitted in R.C. Engine dept. 255 in 1981	255
JM4692	Degreaser removed from dept. 270 in 1980 Retrofit before being moved to dept. 280 in 1981	270/280
JM4601	Degreaser retrofit in 1981	271
JM2528	Degreaser removed in 1980	270/280
JM5023	Degreaser removed in 1980	280
JM4581	Degreaser retrofit in 1981	270
JM4253	Degreaser removed from dept. 241 in 1980 Retrofit before being moved to dept. 280 in 1981	241/248
JM4250 <sup>a</sup>	Degreaser retrofit in 1981	62 (Plant 1) to 248
NA <sup>b</sup>	NA	256
NA <sup>c</sup>	NA	252

**Notes:**

<sup>a</sup> JM4250 was identified in an OMC office memorandum, but the location for the degreaser was never confirmed by other source data. It is unknown if the degreaser was moved to a department other than that listed.

<sup>b</sup> This degreaser was identified as a "wool degreaser" from Johnson Motors Plant 2 Mid and Corp. Sewer Layout. Scale 1"=25'-0", 4-8-74. Revised April 1976.

<sup>c</sup> This degreaser was identified from figure entitled "Site Plan with Sampling Locations and Potential Source Areas" (Golder 1997).

NA = Data not available

Sources: Golder Associates, Inc. 1997. Letter to Mr. Joseph Moran, Re: Proposal/Work Plan for Preliminary Site Investigation and Site Remediation Program Work Plan Preparation, OMC Waukegan Plant 2, Waukegan, IL.

OMC. rev. 1980. *EPA Degreaser Retrofit Program Figure*.

Zamagne, R. Office Memorandum to H. Davis et al. Subject: Degreaser Program. 1980.

Johnson Motors Plant 2 Mid and Corp. Sewer Layout (D-BL2-2). rev. April 1976. Scale 1"=25'-0", 4-8-74.

**TABLE 1-3**  
Description of USTs and ASTs Identified for Plant 2  
OMC Plant 2

UST I.D. No.	Tank Contents	Location	Capacity (gal)	Date Installed	Date Registered	UST No.	Date IEMA Notified	Date Out of Service	Date of Removal (R) or Abandonment (A)	Soil or Groundwater Sampling?	Comments
2.1	Die Lube	Former Die Cast USTs	15,000	1973	May, 1986	931471	June 2, 1993	May 21, 1993	(R) 1993	Yes	See note a
2.2	Hydraulic Oil	Former Die Cast USTs	15,000	1973	May, 1986	931471	Nov. 27, 1991	May 21, 1993	(R) 1993	Yes	See note a
2.3	Hydraulic Oil & Die Lube Mix	Former Die Cast USTs	15,000	1973	May, 1986	931471	June 2, 1993	May 21, 1993	(R) 1993	Yes	See note a
2.4	Die Lube	Former Die Cast USTs	15,000	--	--	931471	--	--	(R) 1993	Yes	See note a; flow through process tank not regulated as an UST
2.5	Waste Oil	Former Die Cast USTs	15,000	--	--	931471	--	--	(R) 1993	Yes	See note a; flow through process tank not regulated as an UST
2.6	Mineral Spirits	Former Die Cast USTs	15,000	1973	May, 1986	913462	June 2, 1993	May 21, 1993	(R) 1993	Yes	See note a
2.7	#2 Fuel Oil	NW Area of property near water tank	30,000	--	--	--	--	--	(R) 1988/1989	Yes	See note b
2.8	#2 Fuel Oil	NW Area of property near water tank	30,000	--	--	--	--	--	(R) 1988/1989	Yes	See note b
2.9	#2 Fuel Oil	North of west boiler room	20,000	1954	Jan., 1992	--	N/A	June 25, 1992	(A) April 1992	Yes	
2.10	#2 Fuel Oil	North of west boiler room	20,000	1954	Jan., 1992	--	N/A	June 25, 1992	(A) April 1992	Yes	

**TABLE 1-3**  
Description of USTs and ASTs Identified for Plant 2  
OMC Plant 2

UST I.D. No.	Tank Contents	Location	Capacity (gal)	Date Installed	Date Registered	UST No.	Date IEMA Notified	Date Out of Service	Date of Removal (R) or Abandonment (A)	Soil or Groundwater Sampling?	Comments
2.11	#2 Fuel Oil	North of west boiler room	20,000	1954	Jan., 1992	--	N/A	June 25, 1992	(A) April 1992	Yes	
2.40	Trichloroethene	Chip Wringer Room	4,000	1970	May, 1986	--	N/A	Est. 1991	(A) January 2000	No	See note c
2.41	Cutting Oil	Chip Wringer Room	5,500	1960	May, 1986	--	N/A	Est. 1991	(A) January 2000	Soil	See note d
2.42	Cutting Oil	Chip Wringer Room	5,500	1960	May, 1986	--	N/A	Est. 1991	(A) January 2000	Soil	See note d
2.43	See note e	Near Chip Dock	6,000	1955	May, 1986	--	N/A	Est. 1991	(A) January 2000	Soil	See note d
2.44	See note e	Near Chip Dock	6,000	1955	May, 1986	--	N/A	Est. 1991	(A) January 2000	Soil	See note d
2.45	See note e	Near Chip Dock	6,000	1955	May, 1986	--	N/A	Est. 1991	(A) January 2000	Soil	See note d
2.46	See note e	Near Chip Dock	4,400	1955	May, 1986	--	N/A	Est. 1991	(A) January 2000	Soil	See note d
--	Trichloroethene	Plant 2, Department 220	5,500	--	--	--	--	--	--	--	See note f
--	Mineral Spirits	Old Die Cast Area, Department 209	500	--	--	--	--	--	--	--	See note g
--	Nitrogen	Outside	900	--	--	--	--	--	--	--	
--	Waste Concentration Soap	Inside	11,000	--	--	--	--	--	--	--	See note h
--	Waste Coolant	Inside	10,000	--	--	--	--	--	--	--	

TABLE 1-3

Description of USTs and ASTs Identified for Plant 2  
OMC Plant 2

UST I.D. No.	Tank Contents	Location	Capacity (gal)	Date Installed	Date Registered	UST No.	Date IEMA Notified	Date Out of Service	Date of Removal (R) or Abandonment (A)	Soil or Groundwater Sampling?	Comments
--	Die Lubricant	Inside	1,200	--	--	--	--	--	--	--	
--	Die Lubricant	Inside	1,200	--	--	--	--	--	--	--	
--	Die Lubricant	Inside	1,200	--	--	--	--	--	--	--	
--	Cutting Oil	Inside	5,250	--	--	--	--	--	--	--	
--	Cutting Oil	Inside	5,250	--	--	--	--	--	--	--	
--	Hydraulic Oil	Inside	2,200	--	--	--	--	--	--	--	
--	Waste Die Lubricant	Inside	10,000	--	--	--	--	--	--	--	
--	Waste Die Lubricant	Inside	10,000	--	--	--	--	--	--	--	
--	Hydraulic Oil	Inside	15,000	--	--	--	--	--	--	--	
--	Waste Soap/Water	New die cast area/inside	2,000	--	--	--	--	--	--	--	
--	Gasoline	Inside	500	--	--	--	--	--	--	--	
--	Gasoline	South of tanks 2.1 through 2.6	550	--	--	--	--	--	--	--	
--	Unknown	South of tanks 2.1 through 2.6	20,000	--	--	--	--	--	--	--	
--	Unknown	South of tanks 2.1 through 2.6	20,000	--	--	--	--	--	--	--	

TABLE 1-3

Description of USTs and ASTs Identified for Plant 2  
OMC Plant 2

UST I.D. No.	Tank Contents	Location	Capacity (gal)	Date Installed	Date Registered	UST No.	Date IEMA Notified	Date Out of Service	Date of Removal (R) or Abandonment (A)	Soil or Groundwater Sampling?	Comments
--	Soluble Oil	Department 221, in the northwest corner of Trim Building	--	--	--	--	--	--	--	--	

## Notes:

<sup>a</sup> Tank 2.6 failed tightness test in 1991, an incident report was filed with IEPA (#913462). Tanks 2.1 to 2.6 removed in 1993; second incident number assigned based on visual observed during removal (#931471). Because of some non-petroleum impacts (i.e., PCBs). OMC entered both LUSTs into IEPA Site Remediation Program.

<sup>b</sup> These tanks were removed during the Waukegan Harbor remediation to allow for the West Cells to be constructed. No evidence of a release was noted during removal. These tanks were identified as 30,000-gallon tanks from plant drawing D-BL2-2, May 6, 1973 (revised December 20, 1979).

<sup>c</sup> This tank has been listed in various reports as being either a 4,000- or 5,000-gallon tank.

<sup>d</sup> Soil sampling was previously conducted through the bottom of the USTs. Impacts were noted, but were not believed related to the materials stored within the USTs.

<sup>e</sup> These tanks stored waste PCBs, virgin PCBs, and new oil, as well as other substances during their active lives.

<sup>f</sup> This tank was identified from an OMC Appropriation Request (No. 6335) dated March 19, 1971. The work performed included the installation of a underground permachlor storage tank, a replacement tank for an existing deteriorating steel tank that leaked. The work was to be performed from April 1, 1971 to May 1, 1971.

<sup>g</sup> This tank is believed to have been used for metal preparation and for the magnaflux machine located nearby. This UST was abandoned in place.

<sup>h</sup> This tank has also been listed as a 10,000-gallon tank in the Discover Site Visit Report (Tetra Tech 2002).

-- Data not available

Sources: URS/Dames & Moore, 2000; Spectrum Engineering Incorporated, 1998; and Tetra Tech, 2002.

**TABLE 1-4**  
**Summary of Outfalls from OMC Plant 2**  
**OMC Plant 2**

<b>Outfall/Sanitary Sewer Number</b>	<b>Receiving Water</b>	<b>Recharge Source/Area</b>	<b>Status</b>
007	Lake Michigan	Southern portion of Die Cast and Smelter Complex, Trim Building, Triax Building, and Metal Working Area	Included in 1990 NPDES Permit
008	Lake Michigan (Waukegan Harbor)	Outfall 007 and Larsen Marine	Included in 1990 NPDES Permit
009	Lake Michigan (Waukegan Harbor)	Air conditioners Roof drains (325,000 ft <sup>2</sup> )  Floor drains eventually plugged in plant	Historically discharged into former Slip 3 with average flow of 144,000 gpd. Plugged during Waukegan Harbor remediation.
010	North Ditch Tributary to Lake Michigan (appears to have discharged into Crescent Ditch)	Western portion of Old Die Cast Area (Dept. 203 Storage, Dept. 203 Furnace and Ingot Storage)  Floor drains in plant area were plugged  Stormwater from west of EJE railroad tracks	Blueprint dated 1976 indicates that storm sewer reportedly plugged at first catch basin outside of plant
011	North Ditch Tributary to Lake Michigan (appears to have discharged into Crescent Ditch)	Appears to have drained to the outside area north of the Old Die Cast Area of Plant 2	Blueprint dated 1976 indicates storm sewer plugged. May have been removed during remediation and construction of West Containment Cell.
012	North Ditch Tributary to Lake Michigan (appears to have discharged into Crescent Ditch)	Old Die Cast Area	Blueprint dated 1976 indicates discharge was "abandoned and sealed"  Possibly removed for installation of die storage area
013	North Ditch Tributary to Lake Michigan (appears to have discharged into Crescent Ditch)	Old Die Cast Area	Blueprint dated 1976 indicates discharge was "abandoned and sealed"
014	North Ditch Tributary to Lake Michigan (former Crescent Ditch)	Metal Working Area included: Air compressors Air conditioners Chiller, plating room Stormwater runoff	Included in 1990 NPDES Permit
015	North Ditch Tributary to Lake Michigan	Northern portion of New Die Cast and Smelter Complex  Roof drains (runoff area 97,570 ft <sup>2</sup> )	Included in 1990 NPDES Permit

**TABLE 1-4**  
Summary of Outfalls from OMC Plant 2  
OMC Plant 2

Outfall/Sanitary Sewer Number	Receiving Water	Recharge Source/Area	Status
016	North Ditch Tributary to Lake Michigan	Old Die Casting Area and Parts Storage Area  Roof drains (runoff area 278,780 ft <sup>2</sup> )	Included in 1990 NPDES Permit
S-2	North Shore Sanitary District	Plant 2 north sanitary sewer discharge to North Shore Sanitary District	Historically discharged into 51" sanitary sewer leading to North Shore Sanitary District
S-2A	North Shore Sanitary District	Plant 2 west sanitary sewer discharge to North Shore Sanitary District	Historically discharged into 51" sanitary sewer leading to North Shore Sanitary District

Sources include the following blueprints and plans obtained from OMC's files:

Johnson Motors Plant 2, Die Cast Sewer Layout (D-BL2-21). rev. April 1976.

EPA Sludge Sampling Locations. 1976.

Clark, Dietz & Associates Engineers, Inc. 1980. Plant Outfalls & General Drainage Patterns.

**TABLE 1-5**  
**OMC Plant 2 Documents Used in Analytical Database Development**  
**OMC Plant 2**

<b>Date</b>	<b>Document Type</b>	<b>Author</b>	<b>Title/Subject</b>	<b>Laboratory Data Available</b>
September 20, 1979	Report	Warzyn Engineering Inc.	Hydrogeologic Investigation, Outboard Marine Corporation, Waukegan, Illinois	None
July 29, 1980	Report	Warzyn Engineering Inc.	Subsurface Investigation, North Ditch Area, Outboard Marine Corporation, Waukegan, Illinois	None
February 10, 1981	Report	JRB Associates	OMC Technical and Witnessing Case Support, Hydrological Study of Ground Water	None
February 1, 1991	Remedial Action Plans	Canonie Environmental	Design and Analysis Report, Waukegan Harbor Superfund Site, Waukegan, Illinois. Note: only portions of report were available	None
July 15, 1993	Report	Sigma Environmental Services, Inc.	A Report on an Underground Storage Tank Closure Assessment at OMC – Waukegan, 200 Sea Horse Drive, Illinois	CBC Environmental Laboratories, Inc. laboratory reports
	RFP	OMC	Request for Proposal, OMC Waukegan Plants 1 and 2, UST Assessment	None
July 1, 1995	Report	Canonie Environmental	Containment Cells, Pumping Test Report, Waukegan Harbor Remedial Action, Waukegan, Illinois	None
Revised August 28, 1996	Report (partial)	Spectrum Engineering, Inc.	OMC Waukegan, Outfall 015 Storm Sewer Infiltration Reduction Alternatives	Storm sewer PCB sampling results table.
Revised September 11, 1996	Report	Triad Engineering	OMC Waukegan Plant 2, Die Cast UST Removal Area, Residual Soil Contamination Assessment, November 1994 Sampling Data	AST data summary sheets for soil sampling results.
October 15, 1996	Proposal	Golder Associates	Proposal for Die Cast UST Assessment, OMC Waukegan Plant 2	Analytical summary tables included
December 3, 1996	Meeting Notes	OMC	Meeting Agenda, 12/03/96 – 2:00 PM	Analytical reports from Kemron Environmental Services



**TABLE 1-5**  
**OMC Plant 2 Documents Used in Analytical Database Development**  
**OMC Plant 2**

<b>Date</b>	<b>Document Type</b>	<b>Author</b>	<b>Title/Subject</b>	<b>Laboratory Data Available</b>
December 10, 1996 (compiled)	Report	OMC Environmental Affairs Department	Groundwater and NPDES Data Package, OMC Waukegan, compiled December 19, 1996	Summary tables available
December 18, 1996	Letter	OMC	Request for Proposal, Groundwater Investigation	Summary table of groundwater results
January 15, 1997	Meeting Notes	OMC	Meeting Topics, January 15, 1997	
June 30, 1997 to February 23, 1999	Field Note Book	Golder Associates	OMC-Hydrogeologic Study	
July 9, 1997	Letter Report to Marc Willis	Lorrie Franklin/ First Environmental Laboratories, Inc.	Analytical Results	Analytical reports by First Environmental Laboratories, Inc.
August 12, 1997	Letter Report to Marc Willis	GZA GeoEnvironmental, Inc.	In-Field Analytical Survey, OMC – Waukegan Illinois	In-field analytical laboratory reports provided
September 17, 1997	Letter Report to Marc Willis	Lorrie Franklin/ First Environmental Laboratories, Inc.	Analytical Results	Analytical reports by First Environmental Laboratories, Inc.
October 3, 1997	Memorandum	Golder Associates	Results of Hydropunch Survey, UST Assessment, OMC Waukegan Plant 2	NET analytical reports
November 26, 1997	Letter Report to Marc Willis	GZA GeoEnvironmental, Inc.	In-Field Analytical Survey, OMC – Waukegan Illinois	Summary tables provided
December 8, 1997	Report	Ann Arbor Technical Services, Inc. (ATS)	1994 Soil Reconnaissance Survey, OMC-Plant #2 Die Cast UST Area, 90 Seahorse Drive, Waukegan, Illinois	Data summary sheets included
January 14, 1998	Letter	Anthony Montemurro/OMC	LPC #0971900017-Lake County, Waukegan/Outboard Marine Corporation (OMC), LUST Incident Numbers 971736, 921734, and 913462	Summary tables provided

**TABLE 1-5**  
**OMC Plant 2 Documents Used in Analytical Database Development**  
*OMC Plant 2*

<b>Date</b>	<b>Document Type</b>	<b>Author</b>	<b>Title/Subject</b>	<b>Laboratory Data Available</b>
August 26, 1998	Office Memorandum  Note: This memo was included in a RFP for design/build services related to CVOCs in groundwater	Marc Willis/OMC	Waukegan Plant #2 Groundwater	Summary tables available
December 29, 1998	Letter Report	First Environmental Laboratories, Inc.	Analytical Results	Analytical reports from First Environmental Laboratories, Inc.
January 5, 1999	Letter	Rebecca J. Hans/ Microseeps	Final data for samples received on December 12, 1998	Analytical reports from First Environmental Laboratories, Inc.
August 24, 1999 (draft 6/19/99)	Report	Radian International	Biotreatability Study Report, Outboard Marine Corporation, Plant #2 Facility, Waukegan Illinois	Summary tables available
September 13, 1999	Proposal	Radian International	SMAART™ Program For Outboard Marine Corporation, Waukegan Illinois. Note: revised proposal to perform Phase 1 Investigation for SMAART™ Solution submitted in January 2000).	None
September 20, 1999	Report	STS Consultants, Ltd.	Environmental Characterization Activities at the Outboard Marine Corporation's Plant 2 Die Cast Facility Located in Waukegan, Illinois	Analytical and Quality Control Reports from National Environmental Testing, Inc. (NET) included
May 15, 2000	Analytical Results	Kemron Environmental Services	Results for Sample No. L0005328-01	
June 28, 2000	Report	URS/Dames and Moore	Phase I Environmental Site Assessment and Asbestos Survey, Outboard Marine Corporation, Lakefront Property, Waukegan Illinois	None
December 10, 2000	Report  (Revised Draft)	URS/Dames and Moore	Focused Site Investigation Report and Work Plan, Chlorinated Solvent Plume Area, Outboard Marine Corporation Plant 2, Waukegan Illinois	Data summary tables included

**TABLE 1-5**  
**OMC Plant 2 Documents Used in Analytical Database Development**  
**OMC Plant 2**

<b>Date</b>	<b>Document Type</b>	<b>Author</b>	<b>Title/Subject</b>	<b>Laboratory Data Available</b>
August 29, 2001	Report	Camp Dresser & McKee, Inc.  (Note: report prepared for Illinois Department of Natural Resources)	Limited Phase II Environmental Site Assessment, Waukegan North Beach PCB Investigation Near North Beach Park, Waukegan, Illinois	Analytical reports from STAT Analysis Corporation included
October 12, 2001	Report	TechLaw, Inc.	Revised Preliminary Assessment/Visual Site Investigation Report and NCAPS Scoring Report	None
December 4, 2001	Report (Draft)	Christopher Lambesis/USEPA	Sampling and Analysis Report for Outboard Marine Corporation, RCRA Facility	Data summary tables included
April 30, 2002	Report	J. Milton Clark/USEPA	Endangerment Evaluation of Human Health Risks at the Outboard Marine Corporation Site	None
May 16, 2002	Report	J. Milton Clark/USEPA	Rebuttal of May 2, 2002 URS Expert Report, Imminent and Identifiable Harm Assessment, Former OMC Waukegan Plant 2 Facility, Waukegan Illinois	None
May 16, 2002	Fax		Engineering Evaluation for Eliminating PCB Discharges from Outfall 009	Table of PCB results included
May 19, 2002	Report	Tetra Tech EM, Inc.	Discovery Site Visit Report, Outboard Marine Corporation, Waukegan, Lake County, Illinois	Data validation report and analytical data included
May 22, 2002	Office Memorandum	Marc Willis/OMC	Plant No. 2 USTs Summary	
May 28, 2002	Supplemental Report	J. Milton Clark/USEPA	May 28, 2002 supplement to April 30, 2002 endangerment Evaluation of Human Health Risks at the Outboard Marine Corporation Site, April 30, 2002, OMC Waukegan Plant 2 Facility, Waukegan, Illinois	None
December 12, 2003	Report	Tetra Tech EM, Inc.	EPA Removal Action Summary Report	Validated analytical results included

**TABLE 1-6**  
Description of SWMUs and AOCs Identified for Plant 2  
OMC Plant 2

SWMU/AOC Designation	Description	Period of Operation	Location	Physical Description	Wastes Managed	USEPA Conclusions
SWMU 2	Plant 2 Hazardous Waste Sludge Storage Area—Used for storage of hazardous and nonhazardous wastes, PCB products and wastes, and a variety of raw products since 1983. Prior to use as storage building, the building was originally occupied by smelting operations.	1983 to December 2000	Adjacent to southwest corner of Plant 2	Consists of a 200- by 80-foot pole frame covered by corrugated steel walls and roof. Building was modified in 1983 to include 4-inch thick concrete floors surrounded by four-foot tall concrete wall. Minimum of 6-inch tall concrete berms provide secondary containment at building access points. No floor drains observed during VSI.  Wastes and products typically stored in 55-gallon drums, 30-gallon totes and one-cubic yard corrugated chem packs on wooden pallets within segregated groups/areas. The maximum capacity was reportedly 952 drums.	All drummed wastes, with the exception of some waste oils were stored in this building. Historically managed about 25 individual waste streams including: chlorinated solvents, paint plating, PCB and wastewater treatment sludge wastes. In addition, filter media from Paint Waste Satellite Accumulation Areas (SWMU 5) were brought to this unit to be compacted and containerized for offsite disposal.	Limited sampling investigation should be conducted to assess impacts from historical smelting operations.
SWMU 4	Former Vapor Degreaser and Still Areas—Used in support of former plating activities and typically consisted of recessed stainless steel degreasing tanks	1969 to 1988	Total of about 17 degreaser units operated in Plant 2	Larger units used dedicated stills adjacent to each degreaser. Solvent from smaller units were collected and taken to a centralized still serving a dozen or so degreasers. Overhead lines conveyed spent degreaser solvents from larger degreaser tanks to adjacent stills. Recovered solvent was reintroduced into the degreaser and still bottoms were removed periodically for off-site disposal.	Units used TCE which was processed by stills and recycled. Still bottoms and spent TCE were generated at collective annual rates of up to 50,000 gallons.	Continue investigation of TCE plume and evaluate appropriate remedial alternatives.
SWMU 5	Paint Waste Satellite Accumulation Areas— Used to manage liquid paint mixing and cleanup wastes, and paint mixing container liners	1996 to December 2000	Adjacent to paint booths	Consisted of multiple 55-gallon steel drums situated over the concrete floor adjacent to the paint booths. In addition, filter media was reportedly collected in wheeled hoppers and taken to the Plant 2 Hazardous Waste Sludge Storage Area.	Managed a variety of liquid paint wastes in addition to spray booth filter media and paint mixing container liners. In addition, a number of clean-up wastes were generated. Methylene chloride wastes (F002) were generated at an annual rate of 300 gallons, waste paint (D001 and D007) was generated at a rate of 2,200 gallons annually and removed for offsite disposal, paint residue (D007 and F017) was generated at a rate of 25,000 gallons annually and removed for offsite disposal, paint thinners (D001 and F005) were generated at a rate of 1,000 gallons annually and reclaimed, SC1000(paint thinner) (D001, F017, D007, and D008) was generated at a rate of 2,500 gallons annually, and removed for offsite disposal.	No further action recommended.
SWMU 6	Die Cast Satellite Accumulation Areas—Used for the collection of hazardous waste die lubricants and oily sludges generated during casting activities	Prior to 1953 to December 2000	In about 1952, relocated from Plant 1 to the western end of Plant 2. In about 1975, operations moved to easternmost end of Plant 2.	Materials accumulated in 55-gallon drums within the die cast area. Once full, drums were taken to Plant 2 Hazardous Waste Sludge Storage Area prior to offsite disposal.	Managed waste oil sludge (about 15,000 gallons per year) and small quantities of waste die lubricant residues.	No further action recommended.

**TABLE 1-6**  
Description of SWMUs and AOCs Identified for Plant 2  
OMC Plant 2

SWMU/AOC Designation	Description	Period of Operation	Location	Physical Description	Wastes Managed	USEPA Conclusions
SWMU 7	Machining Lubricant Recovery Systems and Waste Storage Areas—Used to manage wastes associated with the machining of various aluminum and, from the late 1960s to the late 1990s, cast iron marine engine components	Initiation of facility operations to December 2000	Adjacent to machining operations. In addition, two former recovered metal turnings ("chips") management area located along the north side of Plant 2.	<p>Until about 1995 or 1996, the majority of these oily turnings were collected by a series of trench drains/conveyors that transported the spent machining oils/oily turnings to one of two wringers and the chips were removed to an outdoor hopper. Beginning in about 1996 and following the decommissioning of the conveyor system, machining oils /oily turnings were collected in large wheeled hoppers located at each machining unit. The hoppers were then wheeled to the wringers for processing. In about 1999, most machining operations were relocated and the wringer systems were removed from operation.</p> <p>At the wringers, machining oils/oily turnings were conveyed into large gravity drainage bins. Oils were drained from chips, collected and returned to the machining process. Remaining chips were removed and stored chip management areas consisting of steel hoppers. One hopper s situated over a rail spur adjacent to the wringer area and the other hopper was located due west of the chip wringer area. In addition, what appeared to be a fourth chip management area was identified within the northern loading dock area where former USTs 2.43 through 2.46 were located.</p> <p>Kerosene was reportedly used in a honing process, aluminum sludges were produced in an aluminum machining process, and various more specialized machining processes produced limited quantities of process-specific oily wastes.</p> <p>Oily stains/accumulations of chip material were noted beneath the remaining outdoor fixed steel hopper along the rail spur. Staining was also noted on the exterior concrete wall outside of he chip wringer area. In addition, two stormwater sewers located beneath the outside steel hopper were noted to contain an oil/water liquid. These storm sewers were reportedly capped.</p>	Reportedly managed aluminum sludge removed for offsite disposal, kerosene honing wastes (D001) removed for offsite disposal at an annual rate of about 2,500 gallons, and oil machining wastes removed for offsite removal at an annual rate of 15,000 gallons.	Units should be further evaluated for the presence of contamination and the need for potential remediation.
SWMU 8	Waste Oil Accumulation and Storage Areas—Used to managed waste oil generated during production and maintenance activities	Initiation of facility operations to December 2000	Throughout the plant	Waste oils collected at numerous process and maintenance locations throughout the plant in a variety of containers ranging from 55-gallon drums to mobile vacuum collection unites with capacities of several hundred gallons. Oil from mobile collection units were then bulked in a number of large ASTs and USTs while drums were taken to one of several waste oil drum storage areas.	Managed a variety of hazardous and nonhazardous oils in 55-gallon drums and numerous ASTs and USTs. Hazardous oils associated with cyanide heat treating were generated at about 3000 gallons annually, while other unspecified machining lubricants/oils were generated at collective quantities exceeding 630,000 gallons annually.	No further action recommended.
SWMU 9	Waste Coolant Accumulation and Storage Areas—Used to manage water soluble machining coolants/oils generated during the machining of aluminum	Current units began in the late 1980s and were removed from operation in December 2000	Adjacent to machining equipment and a bulk storage AST (Tank 2-50) located in the old Trim Building	Coolants were collected in 300-gallon concrete sumps adjacent to each machining unit. Periodically removed by mobile coolant collection units and bulked in Tank 2-50, a 10,000 gallon AST, prior to offsite disposal.	Managed water soluble machining lubricants/oils at a total rate of 400,000 gallons annually. Prior to early 1990s, waste coolants were considered hazardous due to elevated concentrations of hexachlorobenzene. Following product modification by the coolant supplier, waste coolants were reported managed as a nonhazardous waste.	Sampling activities should be conducted in and around these units to confirm lack of release.

**TABLE 1-6**  
Description of SWMUs and AOCs Identified for Plant 2  
OMC Plant 2

SWMU/AOC Designation	Description	Period of Operation	Location	Physical Description	Wastes Managed	USEPA Conclusions
SWMU 10	Die Wash System Waste Accumulation and Storage Areas—Used to wash dies in the casting of marine engine parts	Initiation of facility operations to December 2000	Near the "smelter building"	Most recently, the system used a nonhazardous "soap," though past operations relied on a hazardous caustic wash solution. Since 1996 to 1997, washwater from the current die wash system was processed through a membrane filtration system.	The most current system produced about 25,000 gallons of spent non-hazardous oil soap solution annually. These wastes were managed onsite in various tanks prior to offsite treatment/reclamation. Historical operations reportedly generated a collective total of about 30,000 to 50,000 gallons of spent caustic cleaners (D002, D007, and D008) annually into and possibly beyond the early 1980s. Spent caustic solutions were managed in various tanks prior to offsite treatment.	No further action recommended.
SWMU 11	Smelting Waste Storage Areas—Outdoor locations used to manage smelting wastes	In about 1952, relocated from Plant 1 to the western end of Plant 2. In about 1975, operations moved to easternmost end of Plant 2.	Most recently located just east of the die cast area in Plant 2	Smelting wastes consisted of refractory brick and mortar, aluminum dross and potentially other similar materials.  For an unspecified period prior to mid-1980s, smelting wastes were stored in unpaved outdoor locations. One location include an area east of the Plant 2 die cast area. Most recently, smelting wastes were managed in roll-off containers staged in outdoor areas.	Used for storage of aluminum dross and refractory brick and mortar. Aluminum dross was generated at a rate of about 1,600,000 pounds annual and was removed for offsite disposal. Refractory brick and mortar generation rates are unknown.	Potential of release of hazardous constituents in unpaved outdoor locations.
SWMU12	Spent Lighting Accumulation and Storage Areas—Used to manage a variety of spent light elements, most commonly including mercury-containing fluorescent light bulbs	Unknown	Throughout the plant	Spent bulbs were staged in several areas throughout the plant. Once a sufficient quantity had been accumulated, they were taken to the Plant 2 Hazardous Waste and Product Storage Building for storage prior to offsite recycling.	Primarily managed spent mercury-containing fluorescent light bulbs.	No further action recommended.
SWMU 13	Spent Battery Accumulation and Storage Areas—Used to manage a variety of spent batteries commonly including small alkaline and nickel cadmium batteries and lead acid vehicle batteries	Unknown	Throughout the plant	Spent batteries were staged in several areas throughout the plant in five-gallon buckets and on pallets. Once a sufficient quantity had been accumulated, they were taken to the Plant 2 Hazardous Waste and Product Storage Building for storage prior to offsite recycling.	Manage spent metals-containing batteries.	No further action recommended.
SWMU 15	Plant 2 Wastewater Pretreatment System	About 1969 to December 2000	Location of treatment tanks varied during use	System received wastewater from plating system. Wastewater pretreatment included hexavalent chromium reduction by sodium bisulfite, neutralization, metals precipitation, clarification, final pH adjustment and sludge removal. The resulting filter cake was placed in one-cubic yard corrugated containers and stored in the Plant 2 Hazardous Waste and Product Storage Building (SWMU 2) prior to removal for offsite disposal. The wastewater from the filter press was then reprocessed through the entire system. The system reportedly processed water at a rate of 70 gallons per minute, and had a maximum capacity of 100 gpm. The chromium reduction system operated at a rate of about 15 to 20 gpm.	Generated hazardous waste filtercake (D007, F006 and F019) that was stored for offsite disposal.	No further action recommended.

**TABLE 1-6**  
Description of SWMUs and AOCs Identified for Plant 2  
OMC Plant 2

SWMU/AOC Designation	Description	Period of Operation	Location	Physical Description	Wastes Managed	USEPA Conclusions
SWMU 17	Process Tank and Maintenance Waste Accumulation Areas	Initiation of facility operations to December 2000	Throughout the plant	<p>Typically consisted of 55-gallon steel drums that were located adjacent to various process units. Periodic maintenance of plating, heat treating, resin coating and other process tanks generally involved the removal of residues on a limited basis and generated a small quantity of waste. The majority of the plating and heat treating process tank cleanout waste was considered hazardous while much of the remaining wastes were reportedly nonhazardous.</p> <p>Maintenance involving the draining and refilling of various hydraulic oils may have also employed the use of small containers in areas inaccessible by larger equipment.</p> <p>Following accumulation, containerized wastes were taken to Plant 2 Hazardous Waste and Product Storage Building (SWMU 2) prior to removal for offsite disposal.</p>	Managed a variety of metals-containing electroplating bath sludges (D002, D003, D007 and F008), heat treating cyanide sludges (D003 and F012), pickle liquor (K062) and other unspecified hazardous and nonhazardous wastes.	No further action recommended.
SWMU 18	Safety Kleen Parts Washers	Initiation of facility operations to December 2000	Maintenance shop and die repair areas	Consist of Safety Kleen solvent-based parts washers used for various maintenance activities and for the cleaning of dies. Four parts washers were maintained within the general maintenance shop and four within the die repair area.	Units contained a solvent-based parts washing solution managed (i.e., filled, picked up and removed) entirely by Safety Kleen.	No further action recommended.
SWMU 19	On-Site CERCLA Containment Cells	1989 to present	West Cell is at the northwest corner of the property, and the East Cell at the northeast corner	<p>Cells created in association with the remediation of PCB-contaminated sediments in Waukegan Harbor. From about 1961 until 1972, PCB-containing hydraulic fluids associated with aluminum die casting reportedly escaped to the North Ditch and Slip 3. Beginning in 1989, sediments from the harbor (within and surrounding Slip 3) and the North Ditch were dredged and portions thermally treated. Once dredged and/or treated, sediment was placed in the East Cell, the West Cell and in Former Slip 3. These cells were created to serve as containment units. An extraction well system was also installed at each containment cell to maintain an inward hydraulic gradient.</p> <p>Results of post-closure monitoring indicate that PCB groundwater concentrations are generally below detection limits. However, during the April 2000 monitoring event, West Cell MW-10 had a PCB concentration of 1.7 ppb.</p>	These CERCLA containment cells manage PCB-impacted sediment.	No further action recommended.
SWMU 20	Waste PCB ASTs—Used for storage of a variety of PCB materials at varying concentrations	Until 1984	Series of four outdoor secondary containment bunkers at the north central portion of Plant 2	<p>A total of 17 ASTs used to store PCB product and waste PCB materials for unspecified periods.</p> <p>All ASTs were reportedly removed in 1984, only secondary containment diking remains.</p>	Managed both product and waste PCB oils.	No further action recommended.

**TABLE 1-6**  
Description of SWMUs and AOCs Identified for Plant 2  
OMC Plant 2

SWMU/AOC Designation	Description	Period of Operation	Location	Physical Description	Wastes Managed	USEPA Conclusions
AOC A	Plant 2 West End Pipe Chase		Western portion of plant	<p>This unit historically served as a utility pipe chase and a ventilation conduit for smelting and casting operations. Fresh air was forced through the chases by a large fan and vented to reduce temperatures in various work areas. In addition, this chase provided utility access throughout several areas of the plant.</p> <p>When die cast operations were moved to the eastern portion of Plant 2, vents were covered with metal plates and the vent fans were removed. In addition, several pipe chase access points were sealed. During the VSI, the metal plates covering five pipe chase access point were removed and about 2-feet of oily water was observed in the pipe chase.</p>		Recommended that the pipe chase contents be removed, the pipe chase remediated, if necessary, and sealed/backfilled to prevent infiltration or spillage from entering the unit.
AOC C	Leaking PCB-Containing Electrical Equipment			<p>Numerous PCB-containing electrical transformers are present throughout Plant 2. During the VSI, three potential PCB releases were identified. The first potentially leaking transformer (Transformer NO. 8B) was located on the roof. Although the transformer was mounted on a troughed secondary containment pad, oil (potentially containing PCBs) appeared to have leaked from the transformer, through a crack in the secondary containment pad, and onto the roof. The accumulation of oil was less than three feet from a roof stormwater drain.</p> <p>Transformer No. 5 in the tools building was also noted to potentially have been leaking onto the underlying concrete floor.</p> <p>Although the transformer was not observed to be leaking, a pool of black liquid was observed underneath the Transformer No. 31 secondary containment system. The staining was adjacent to a roof drain.</p>		Recommended that cleanup activities be confirmed and the storm drains immediately adjacent to the transformers be evaluated. The integrity of floor beneath Transformer No. 5 should also be performed.
AOC D	Stormwater Conveyance System			<p>System consists of all stormwater conveyance systems, including current and historic drains, lines, detention areas and discharges. Stormwater collected from roofs and parking lots in western portion of the facility is generally discharged to Waukegan Harbor, while stormwater from the ester portion is discharged to Lake Michigan.</p>		Stormwater conveyance system should be evaluated for release potential. Specific system associated with the roof drains should also be evaluated and confirmation stormwater and/or sediment samples be collected from areas near Transformer No. 31 PCB release area.

Source: TechLaw. 2000.



TABLE 1-7

Summary of Wipe Sample Analytical Results<sup>a</sup>  
OMC Plant 2

Type of Surface	Conc. Range <sup>b</sup>			Number Samples				Comments
	Min	Max	Avg	Samples	PCB Detected	Conc. > 10 <sup>c,d</sup>	Conc. > 100 <sup>c,d</sup>	
Floor	0.75	9,140	294.15	48	46	26	7	Some floor areas were decontaminated during USEPA's removal activities
Equipment <sup>e</sup>	1.57	36.9	12.28	19	18	11	0	Some of the equipment was eliminated during USEPA's removal activities
Office Furniture	2.03	3.08	2.54	3	3	0	0	

Notes:

<sup>a</sup>PCB analytical results from USEPA's *Discovery Site Visit Report* (Tetra Tech 2002).

<sup>b</sup>PCB concentrations in ug/100 cm<sup>2</sup>.

<sup>c</sup>The cleanup standard for porous surfaces (e.g., concrete floors) and nonporous surfaces in high occupancy areas is 10 ug/100 cm<sup>2</sup> (40 CFR 761).

<sup>d</sup>The cleanup standard for nonporous surfaces in low occupancy areas is 100 ug/100 cm<sup>2</sup> (40 CFR 761).

<sup>e</sup>Equipment includes tanks and piping.

TABLE 1-8

Summary of Floor Wipe Sample Analytical Results  
OMC Plant 2

Plant Area	Site Visit and Preliminary Sampling <sup>a</sup>							Post Floor Decontamination Sampling <sup>b</sup>						
	Conc. Range <sup>c</sup>			Number of Samples				Conc. Range <sup>c</sup>			Number of Samples			
	Min.	Max.	Avg.	Samples	PCB Detected	Conc. > 10 <sup>b,d</sup>	Conc. > 100 <sup>b,e</sup>	Min.	Max.	Avg.	Samples	PCB Detected	Conc. > 10 <sup>b,d</sup>	Conc. > 100 <sup>b,e</sup>
Chemical Storage Area	1.82	1,130	191	6	6	1	1	NA	NA	NA	0	NA	NA	NA
Old Die Cast Area	1.81	9,140	850	12	12	9	3	261	4,250	2,260	2	2	2	2
Parts Storage Area	22.1	1,190	311	7	6	6	3	148	408	278	2	2	2	2
Metal Working Area	2.6	65	20.5 15.0 <sup>f</sup>	39	31	20	0	1.23	18	9.8	9	9	5	0
Main Aisle <sup>g</sup>	23.1	23.1	23.1	1	1	1	0	40.2	119	79.6	2	2	2	1
Trim Building	0.753	0.753	0.753	1	1	0	0	NA	NA	NA	0	NA	NA	NA
New Die Cast Area	1.83	10.6	5.7	10	10	1	0	NA	NA	NA	0	NA	NA	NA

## Notes:

<sup>a</sup>PCB analytical results from USEPA's *Discovery Site Visit Report* (Tetra Tech 2002) and *USEPA Removal Action Summary Report* (Tetra Tech 2003).

<sup>b</sup>PCB analytical results from *USEPA Removal Action Summary Report* (Tetra Tech 2003).

<sup>c</sup>PCB concentrations in ug/100 cm<sup>2</sup>.

<sup>d</sup>The cleanup standard for porous surfaces (e.g., concrete floors) and nonporous surfaces in high occupancy areas is 10 ug/100 cm<sup>2</sup> (40 CFR 761).

<sup>e</sup>The cleanup standard for nonporous surfaces in low occupancy areas is 100 ug/100 cm<sup>2</sup> (40 CFR 761).

<sup>f</sup>The two average values are from the samples from the site visit and the preliminary sampling, respectively.

<sup>g</sup>Main aisle represents area between Parts Storage Area and Metal Working Area and offices or loading docks to the south.

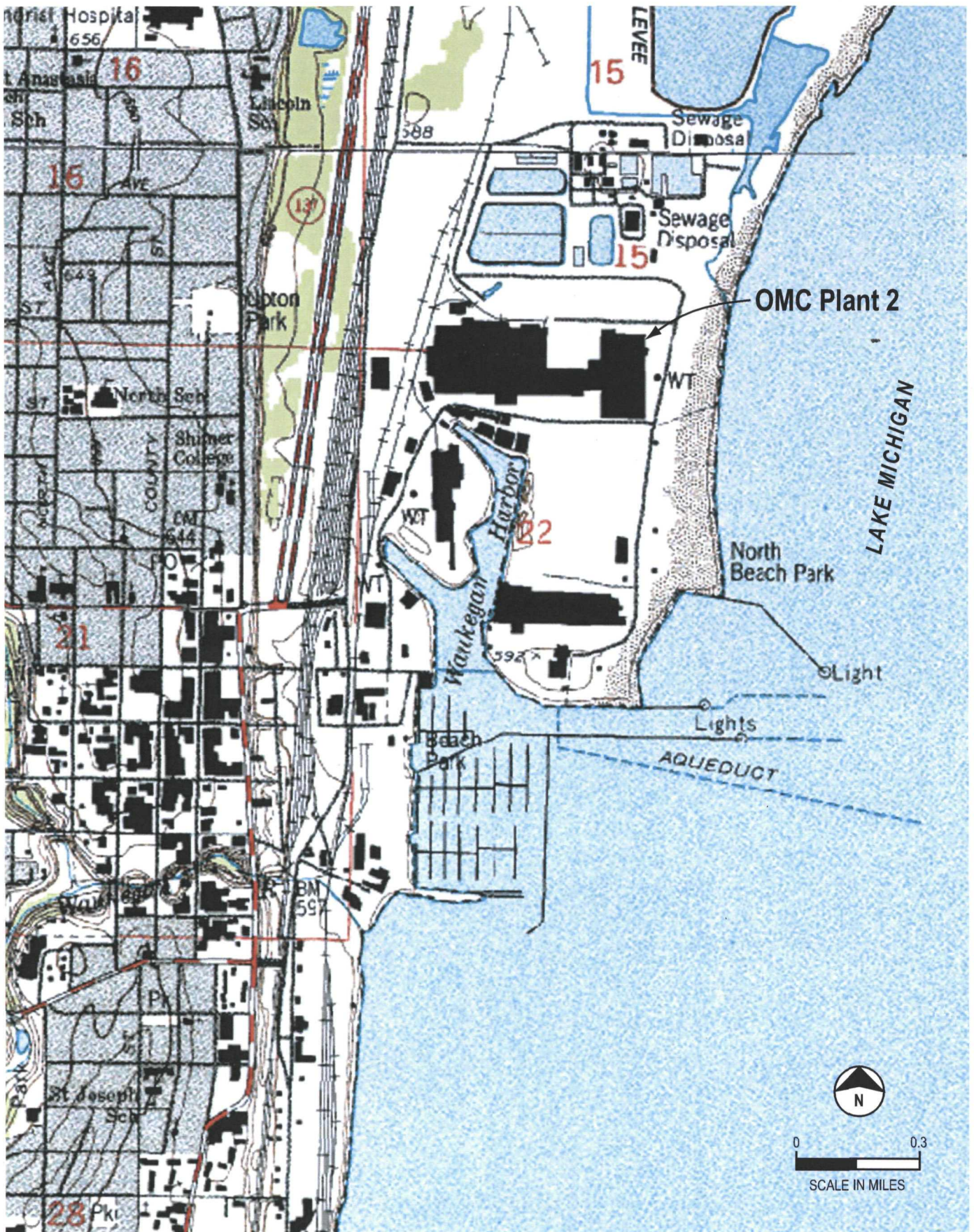
NA = Not applicable

**TABLE 1-9**  
**TCE Concentrations in Soil Versus Depth**  
*OMC Plant 2*

<b>Location</b>	<b>Depth Interval (ft)</b>	<b>TCE Concentration (µg/kg)</b>
GP-1	2-3	19,000
	23-24	7.03
GP-8	3-4	59.7
	24	268,000
GP-15	6	248,000
	30	<6.17

Source: Tetra Tech. 2003.



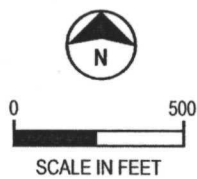
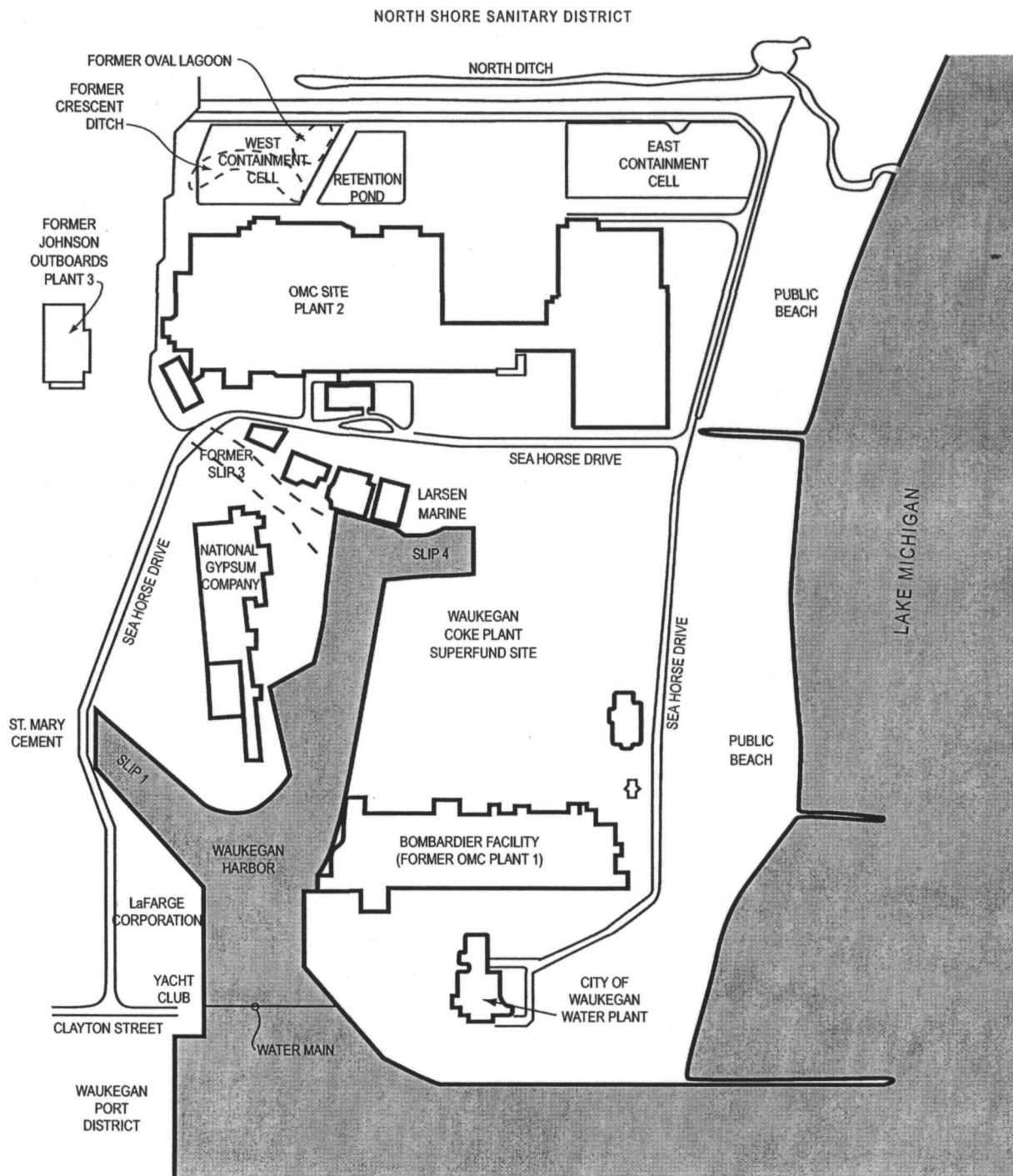


SOURCE: USGS Waukegan Quadrangle Map

Figure 1-1  
**Site Location Map**  
 OMC Plant 2

**CH2MHILL**

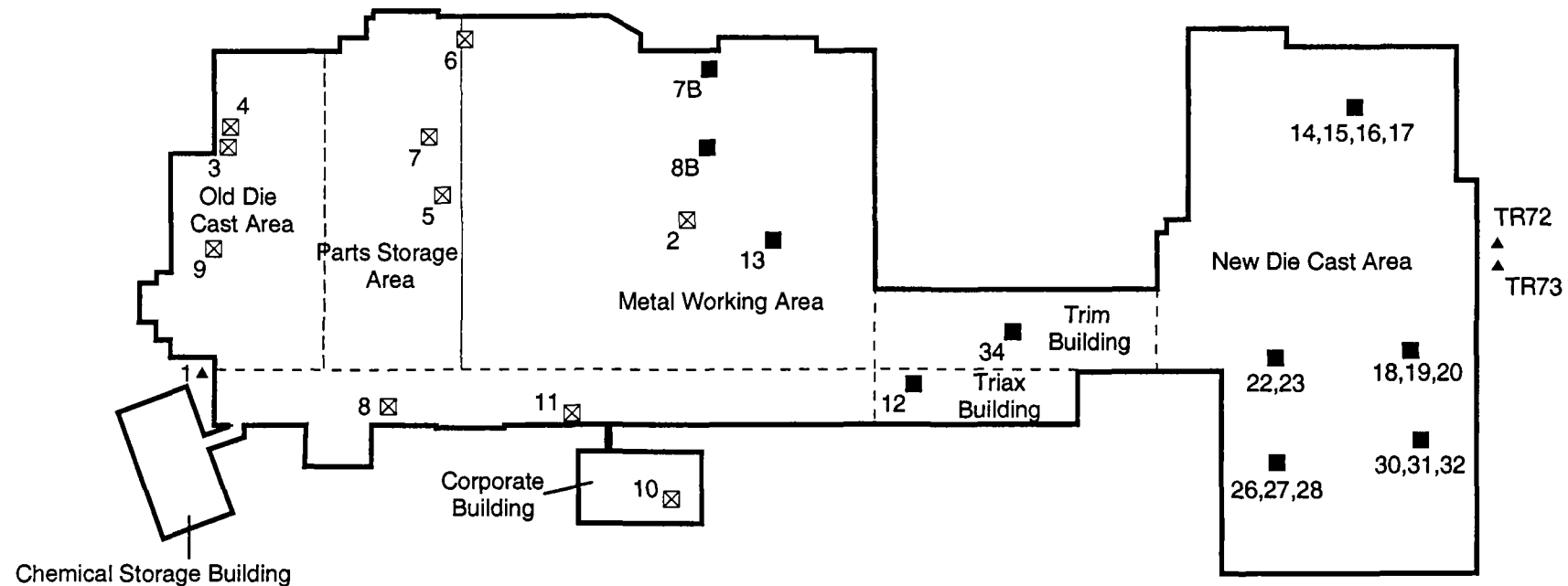
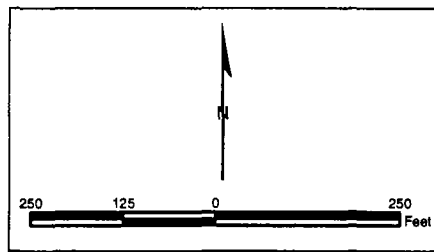




SOURCE: ADAPTED FROM USEPA 2002

Figure 1-2  
**Vicinity Features**  
 OMC Plant 2

**CH2MHILL**



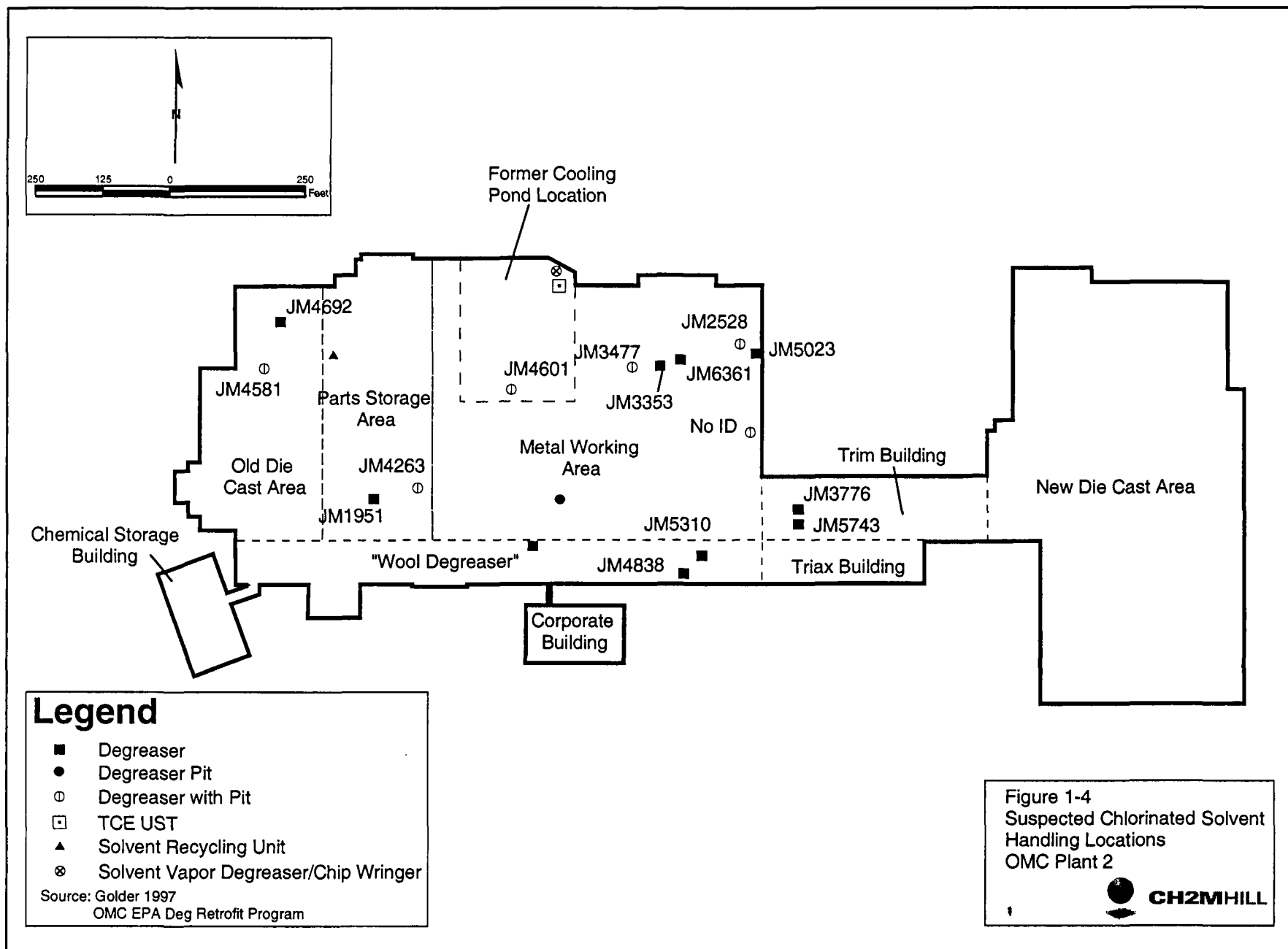
### Legend

- ☒ Inside Building Mounted
- ▲ Outside Yard Mounted
- Roof Mounted

Sources: Tetra Tech 2003  
OMC Figure A-1 Transformer Locations. Not Dated

Figure 1-3  
Transformer Locations  
OMC Plant 2





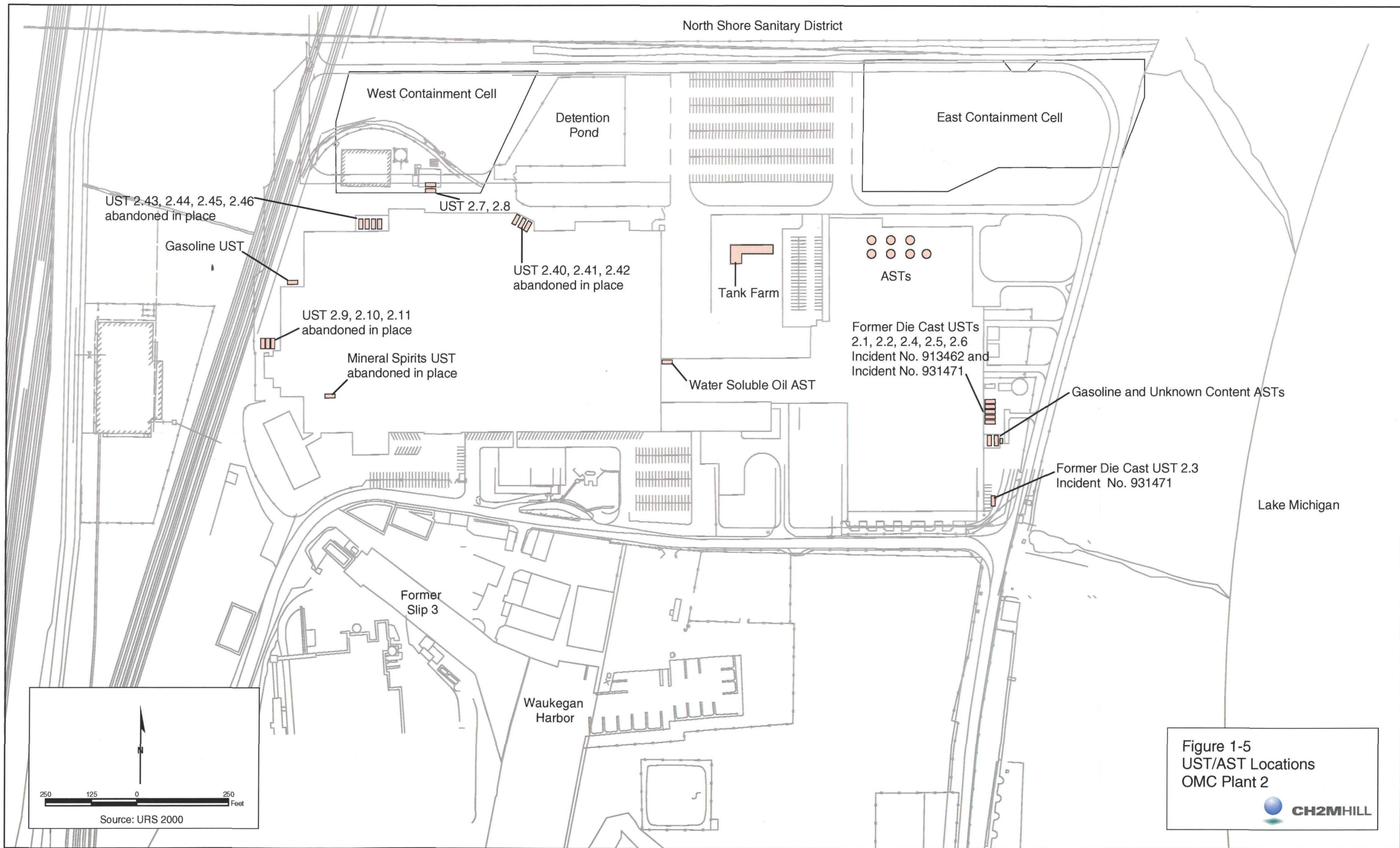
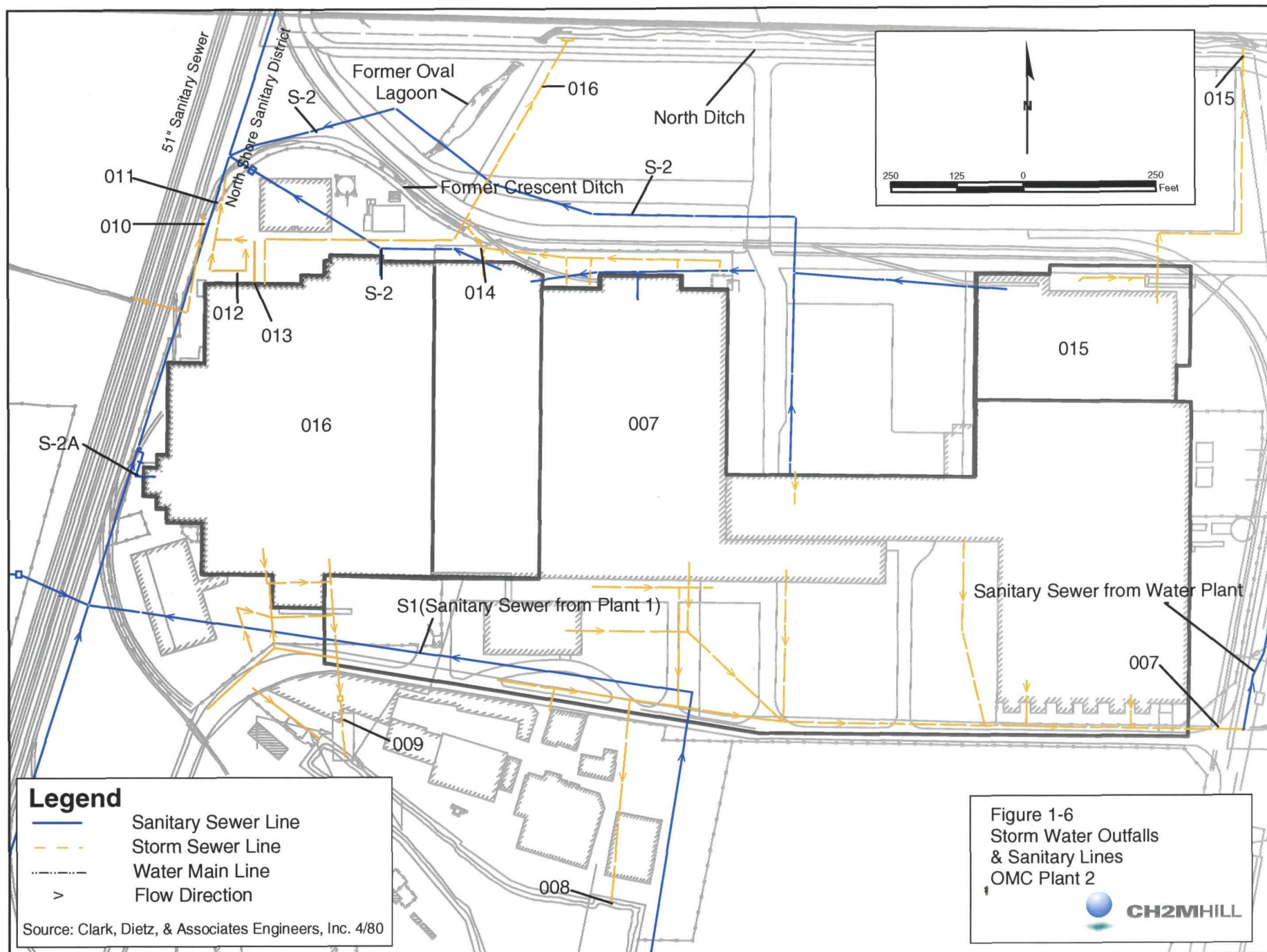
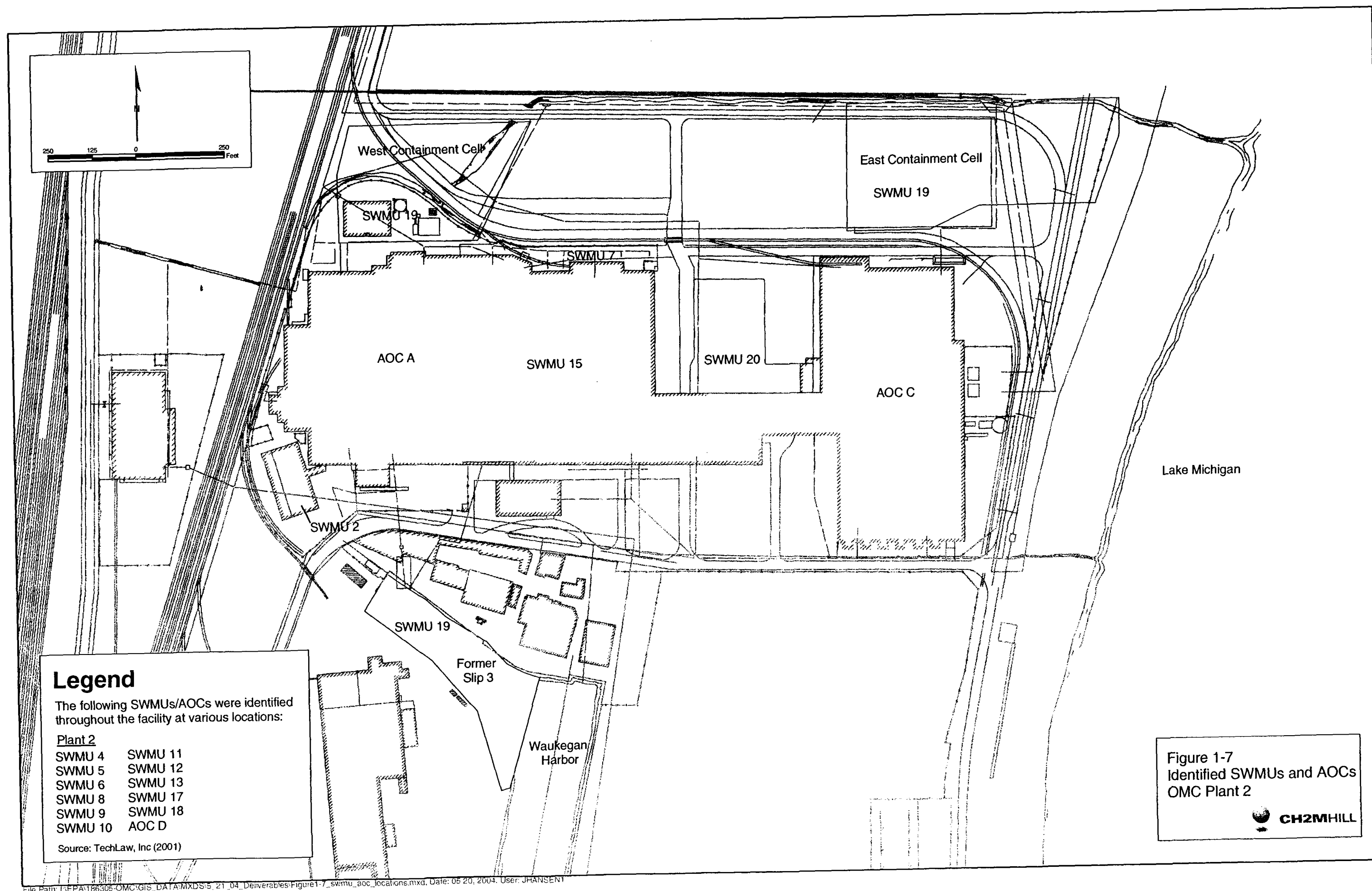


Figure 1-5  
UST/AST Locations  
OMC Plant 2

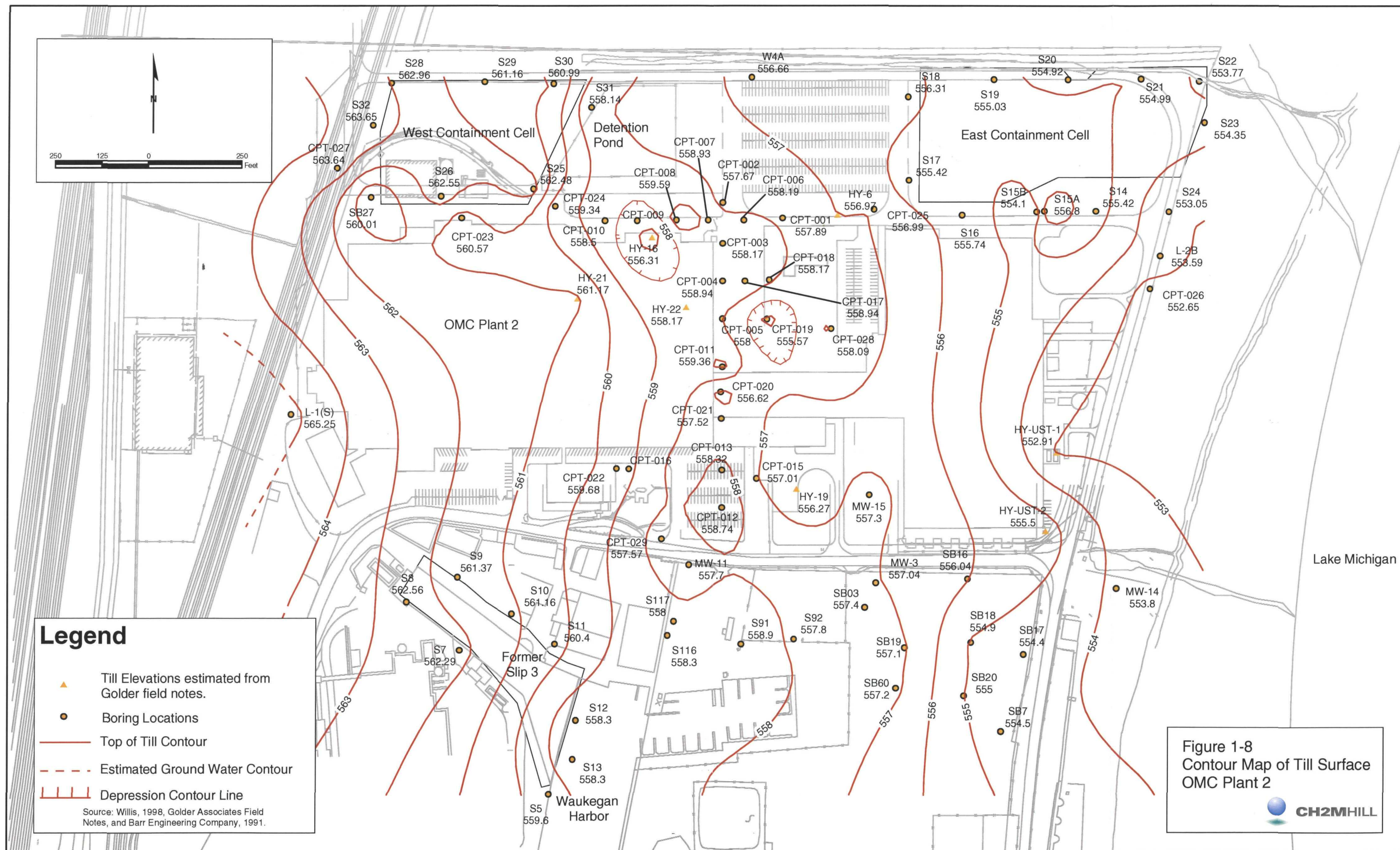




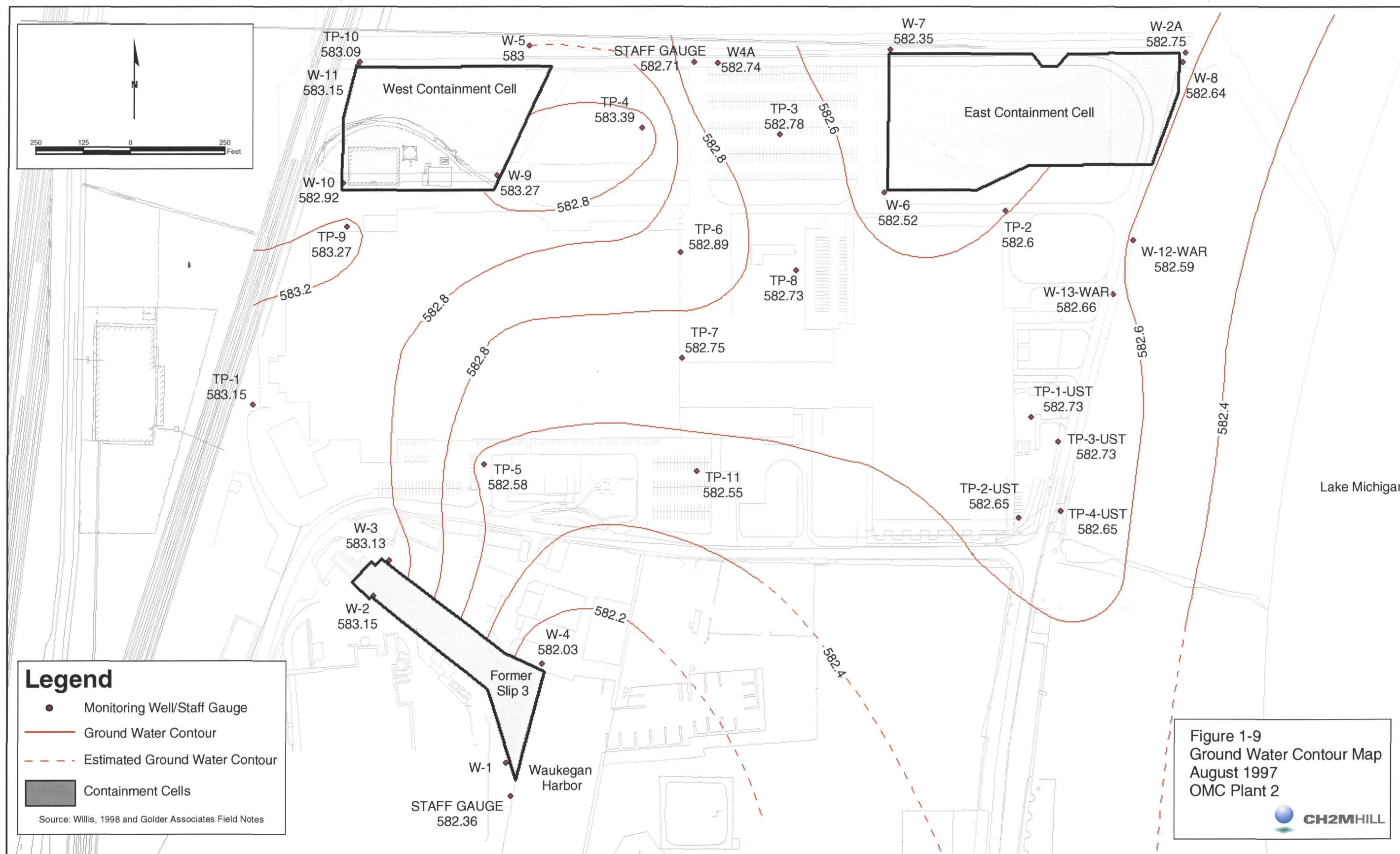




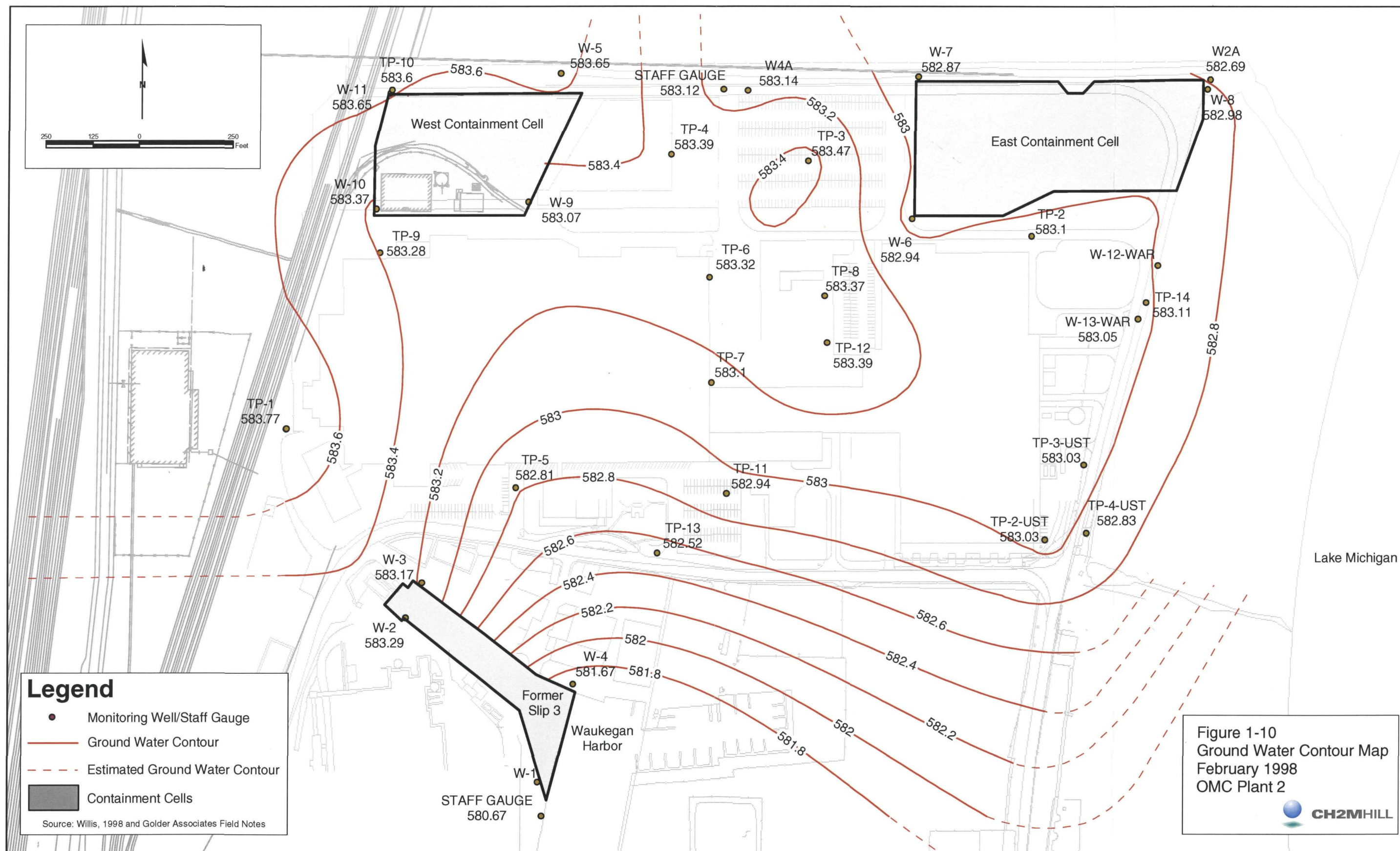














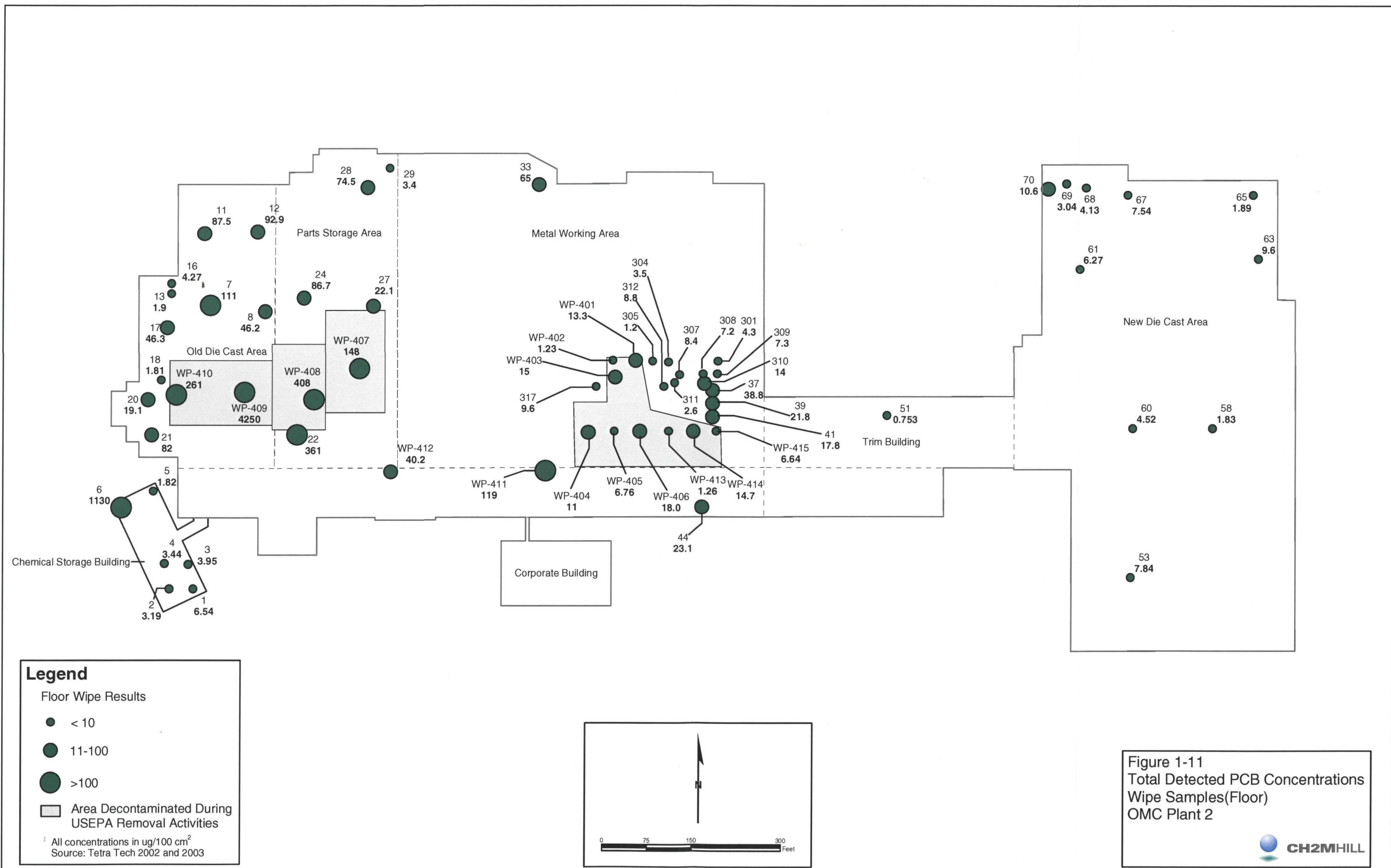
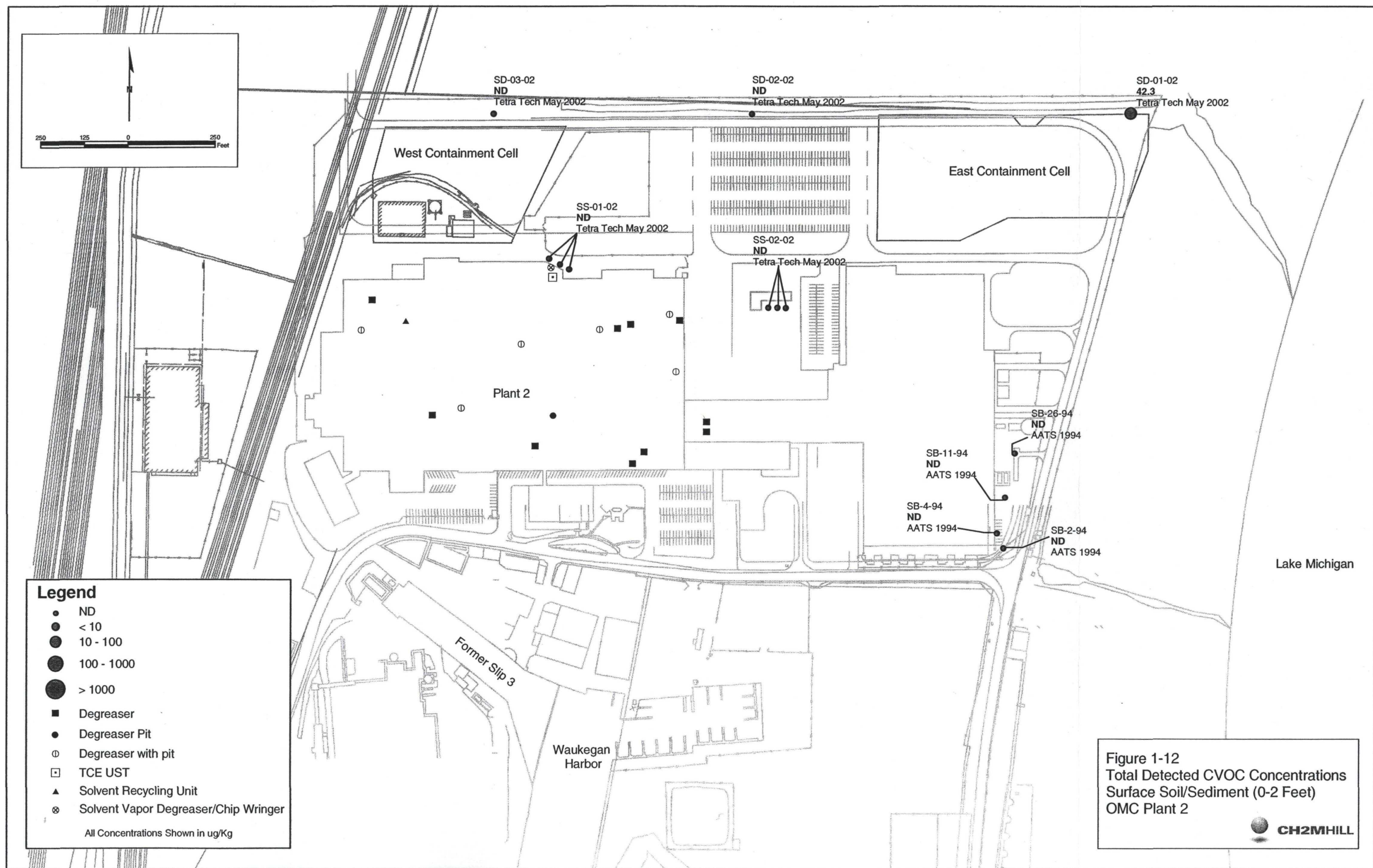


Figure 1-11  
Total Detected PCB Concentrations  
Wipe Samples(Floor)  
OMC Plant 2









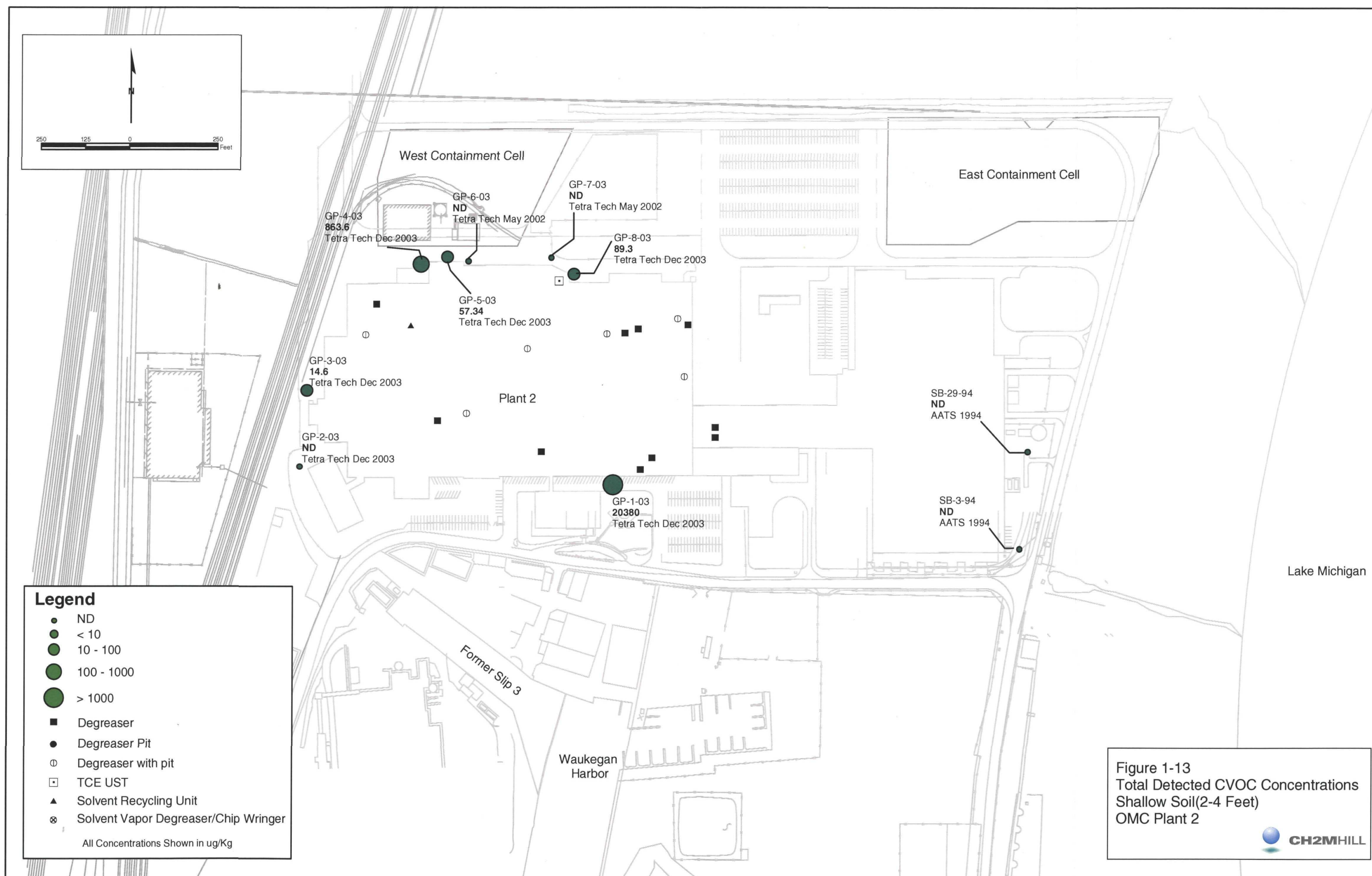


Figure 1-13  
Total Detected CVOC Concentrations  
Shallow Soil(2-4 Feet)  
OMC Plant 2

**CH2MHILL**



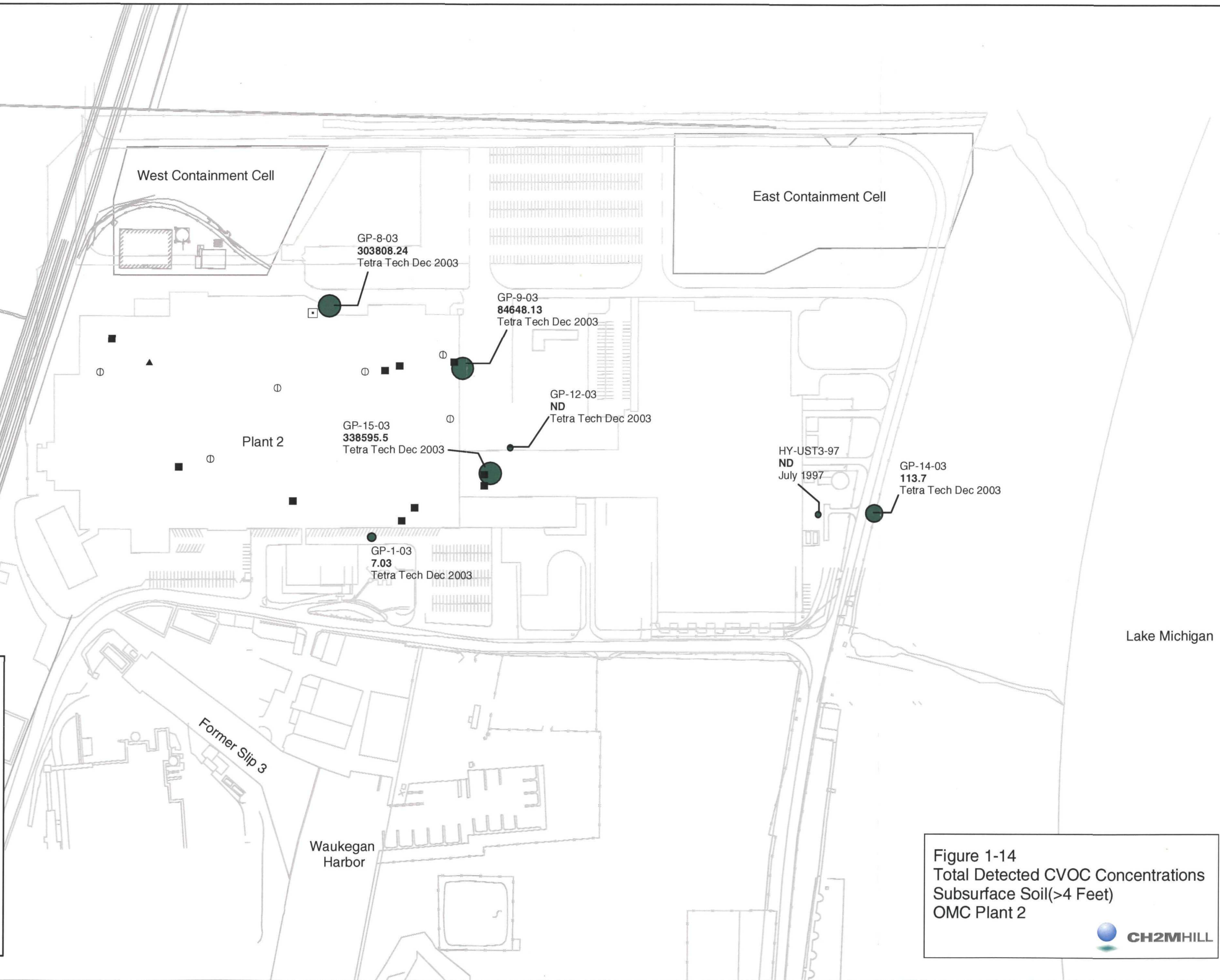
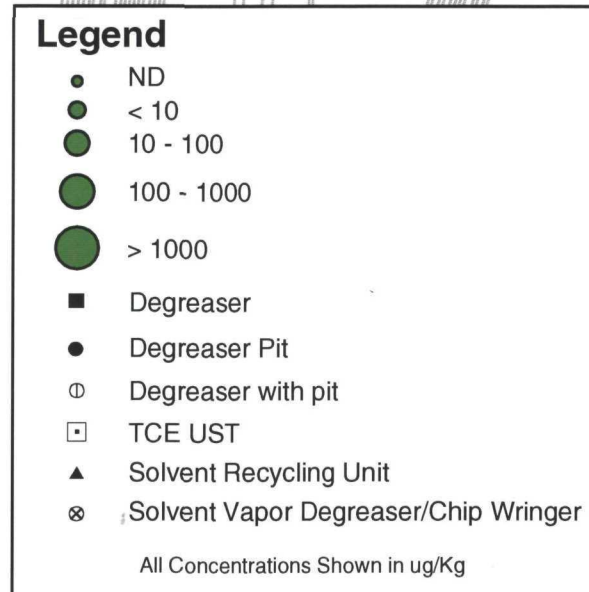
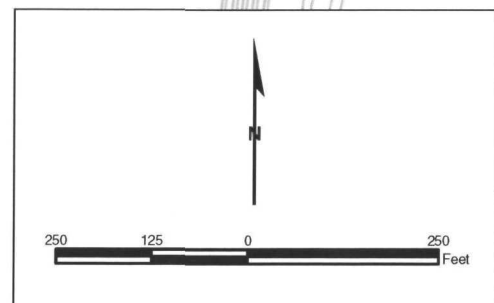
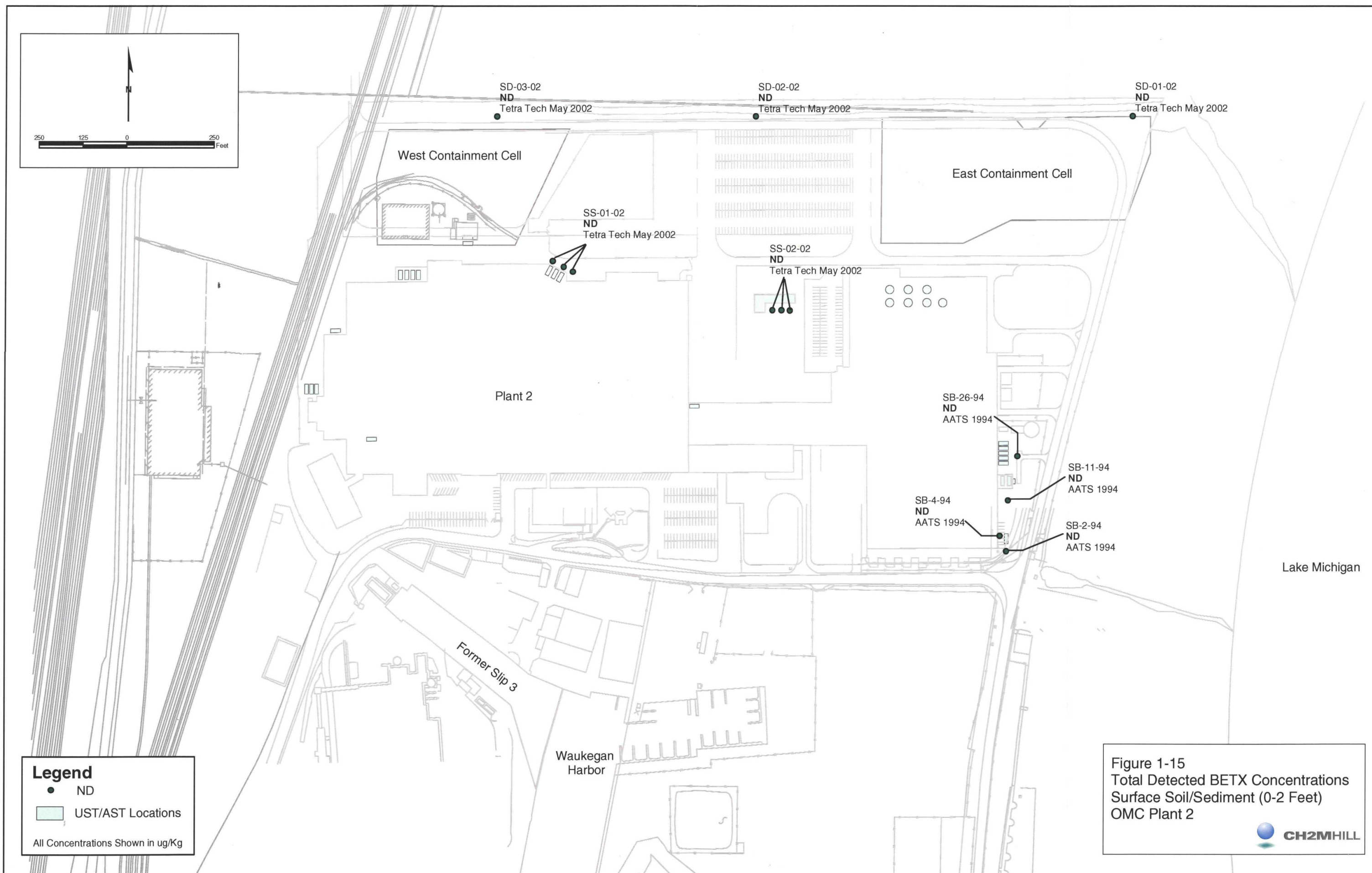


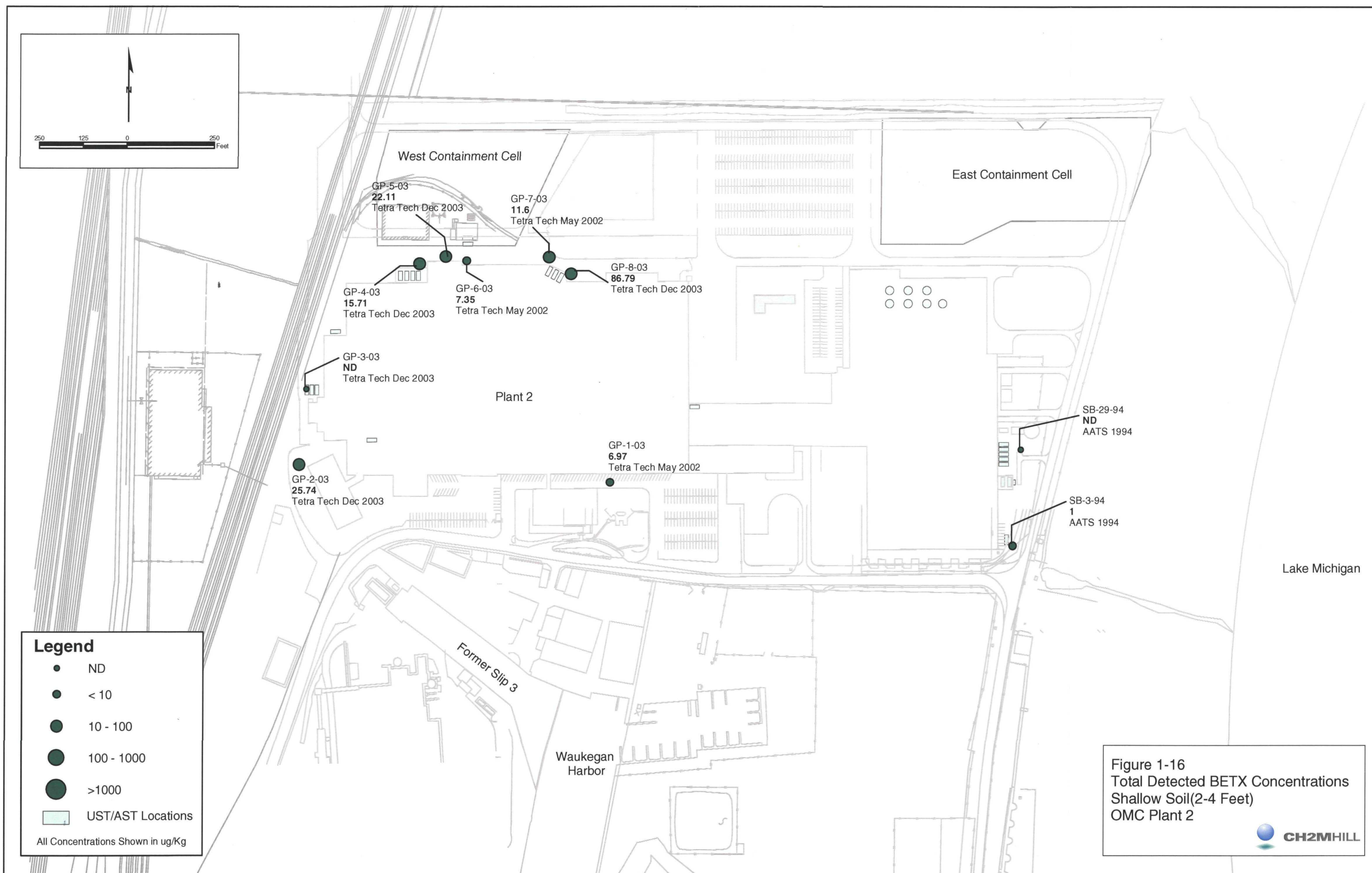
Figure 1-14  
Total Detected CVOC Concentrations  
Subsurface Soil(>4 Feet)  
OMC Plant 2



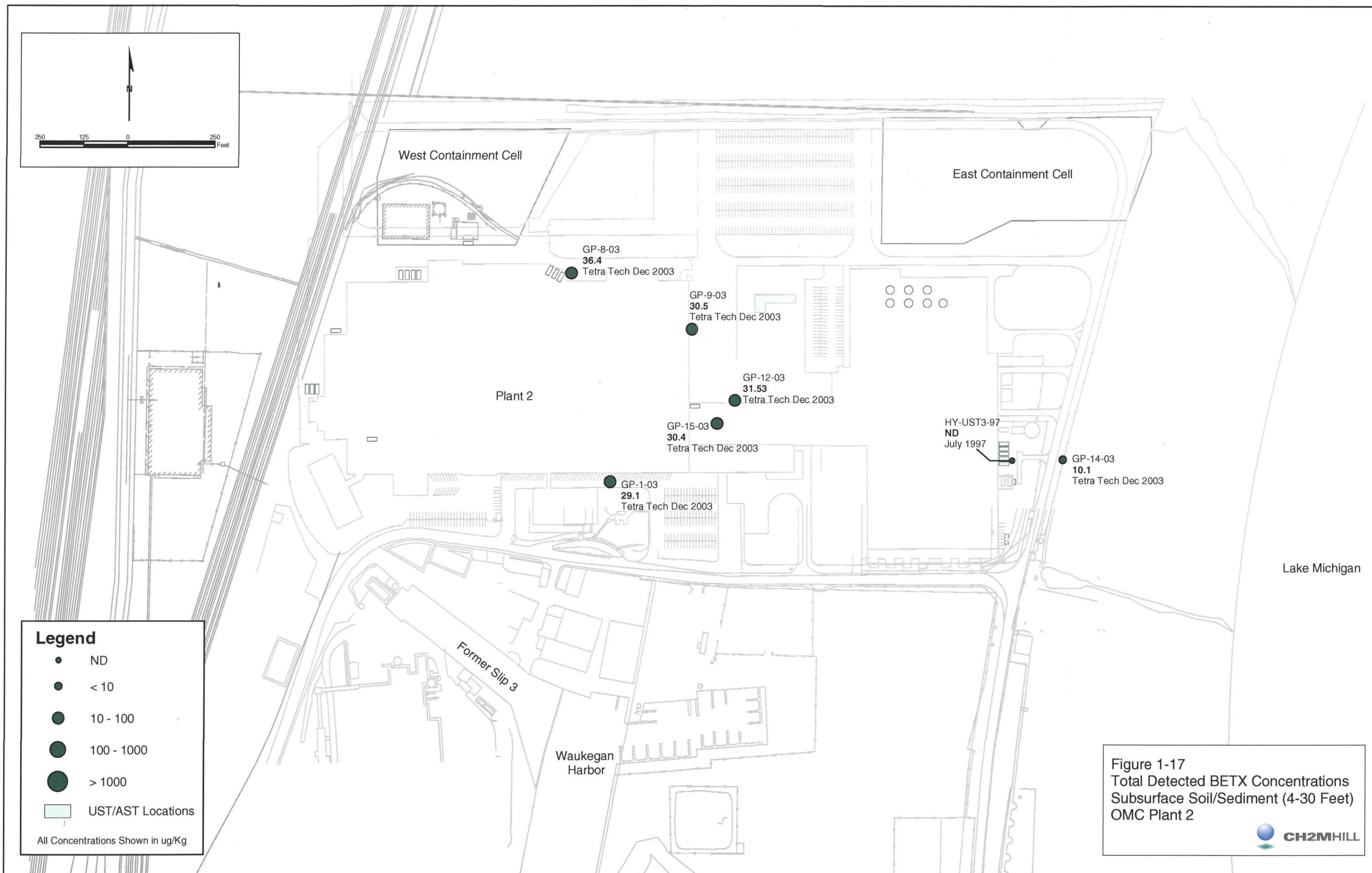


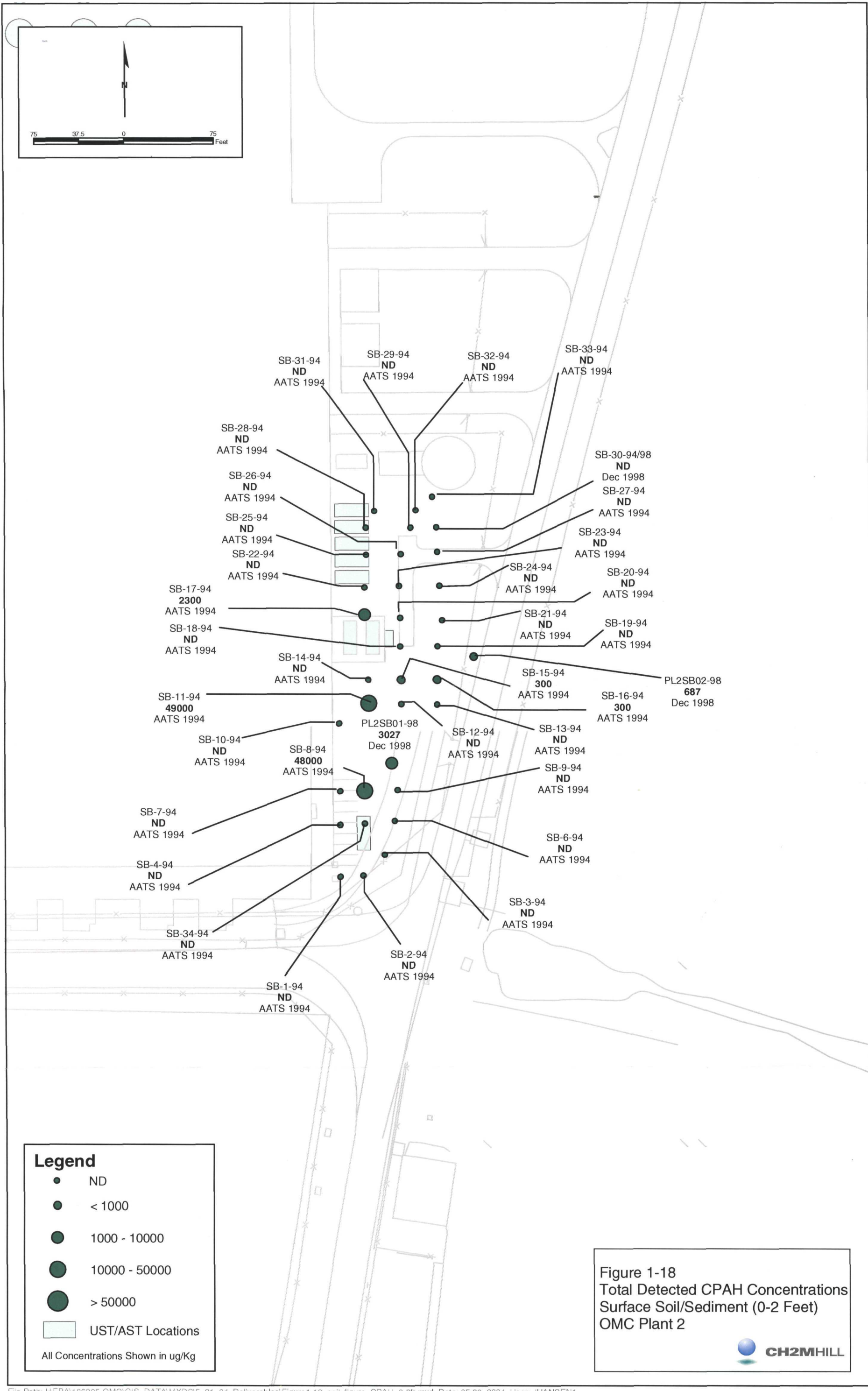
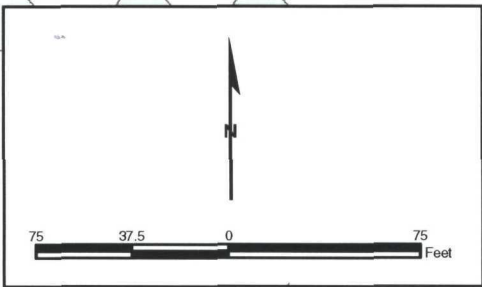




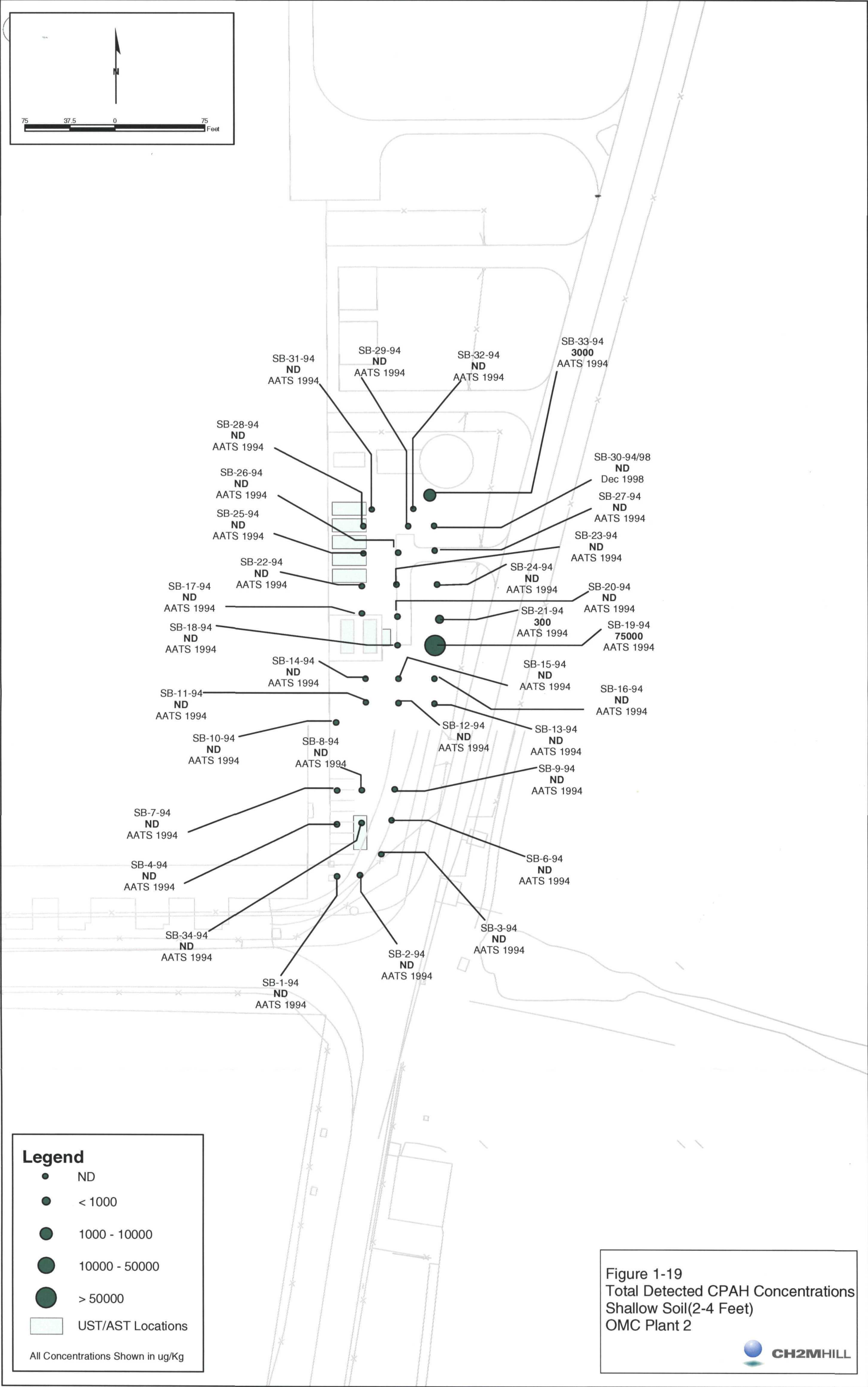


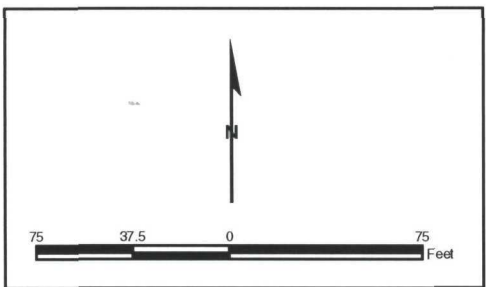












HY-UST3-97  
ND  
July 1997

SB-35-94  
ND  
AATS 1994

SB-20-94  
ND  
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SB-9-94  
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SB-34-94  
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AATS 1994

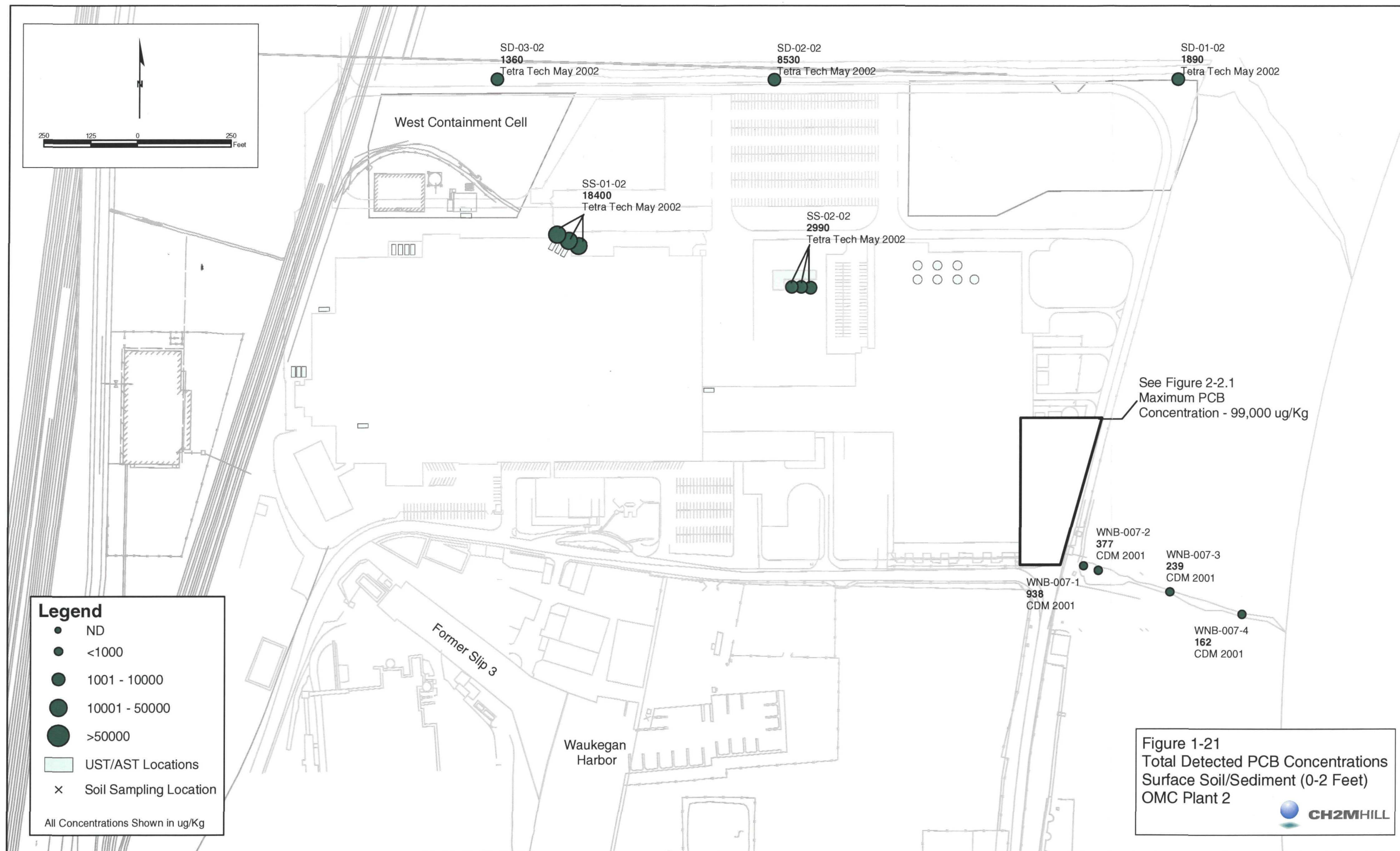
**Legend**

- ND
  - UST/AST Locations
- All Concentrations Shown in ug/Kg

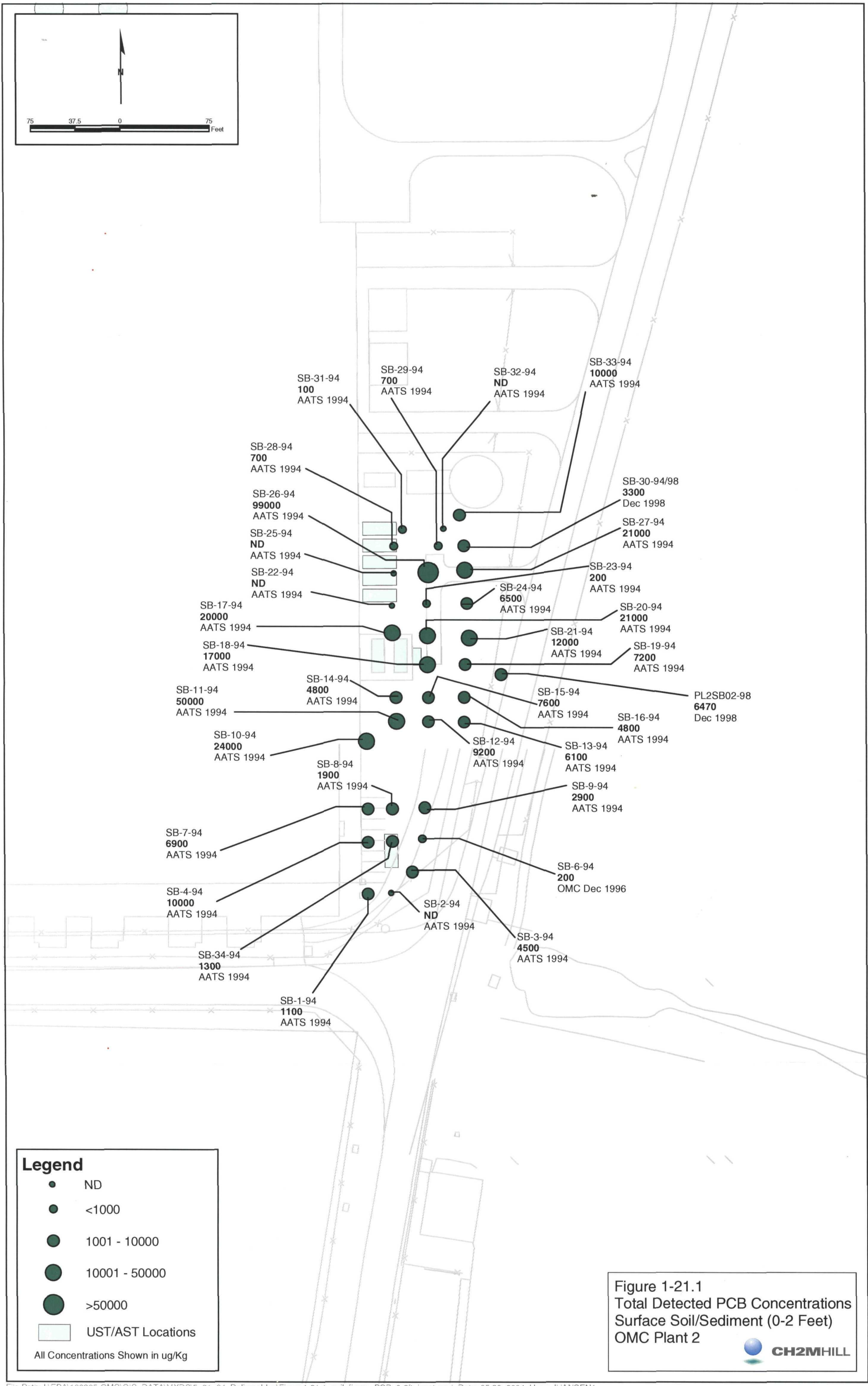
Figure 1-20  
Total Detected CPAH Concentrations  
Subsurface Soil(>4 Feet)  
OMC Plant 2

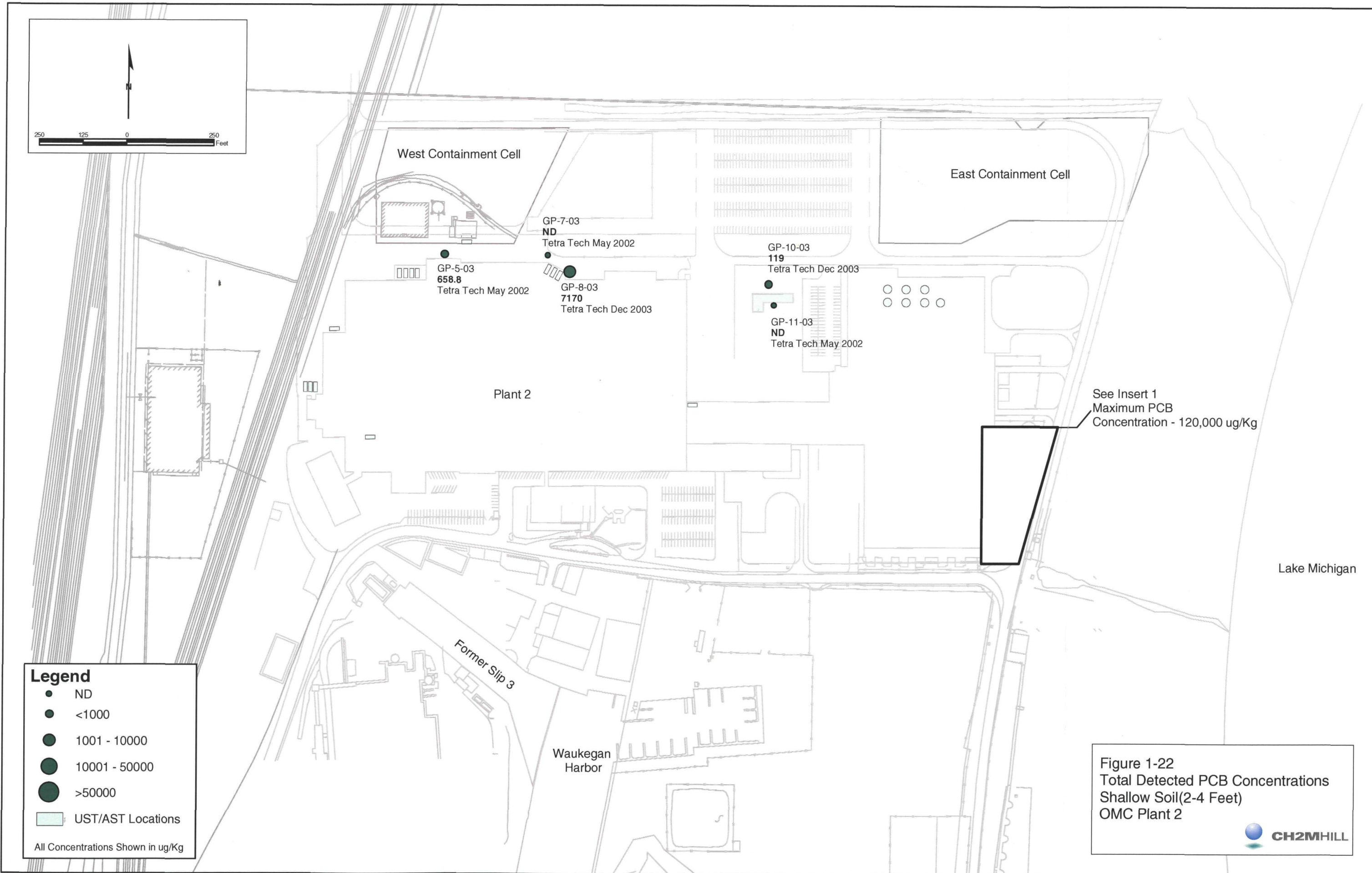














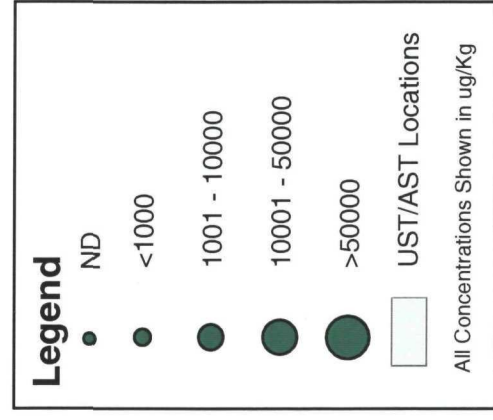
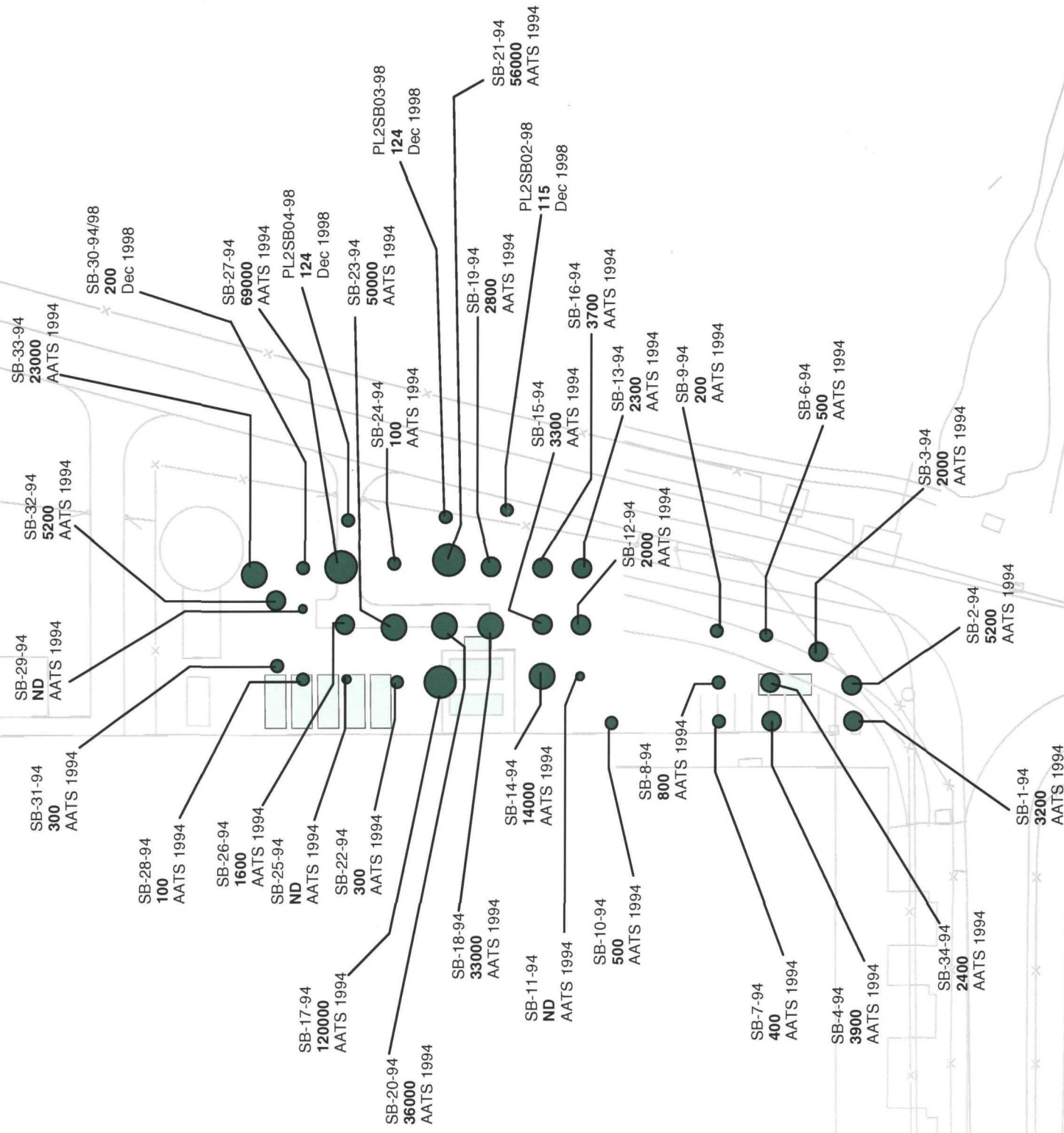
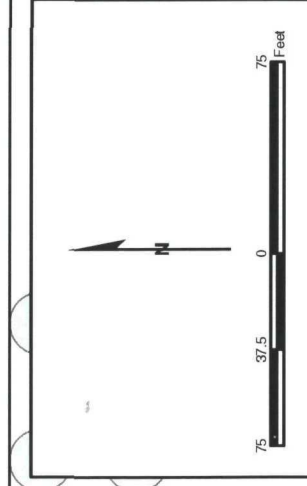
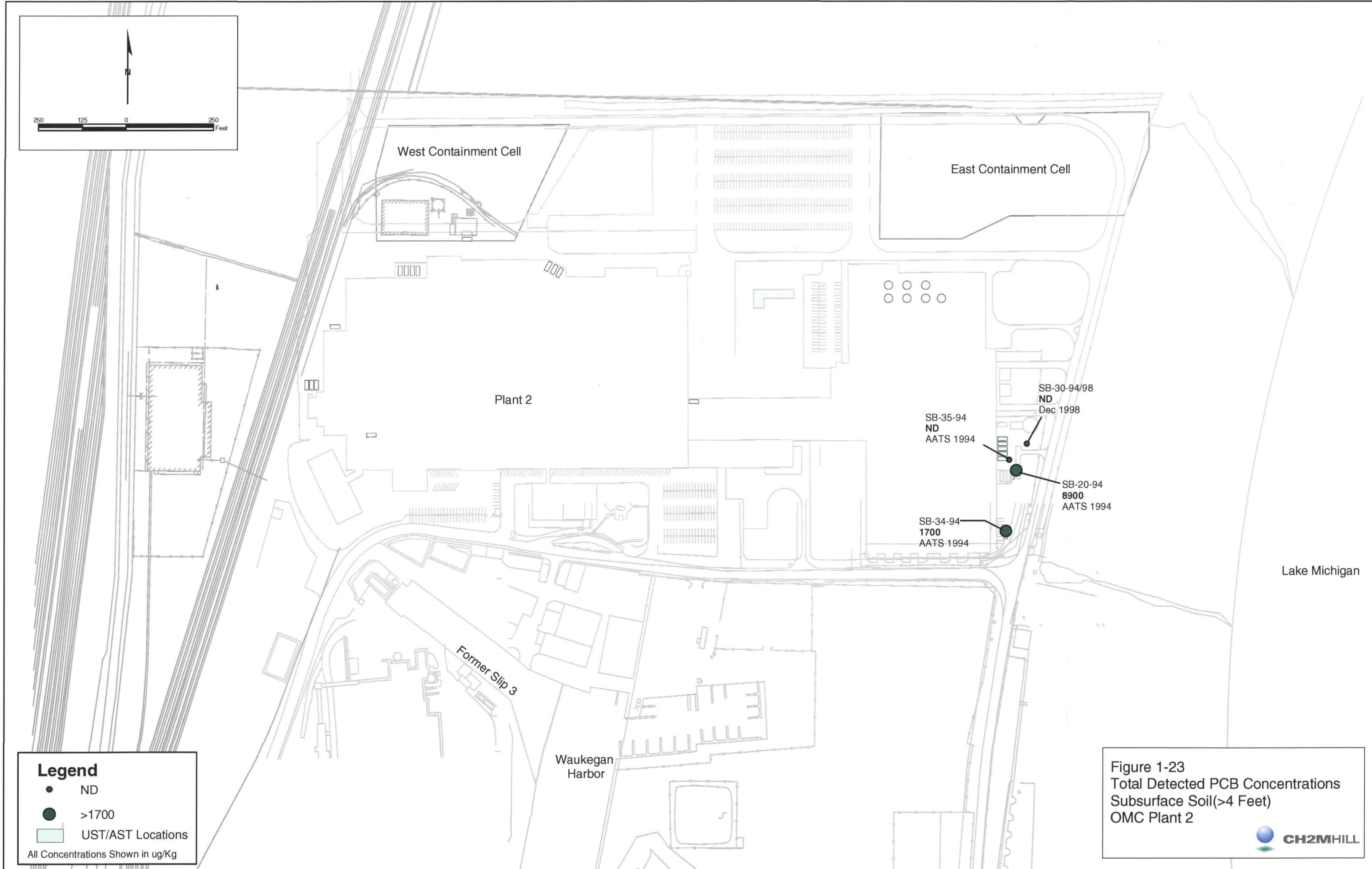
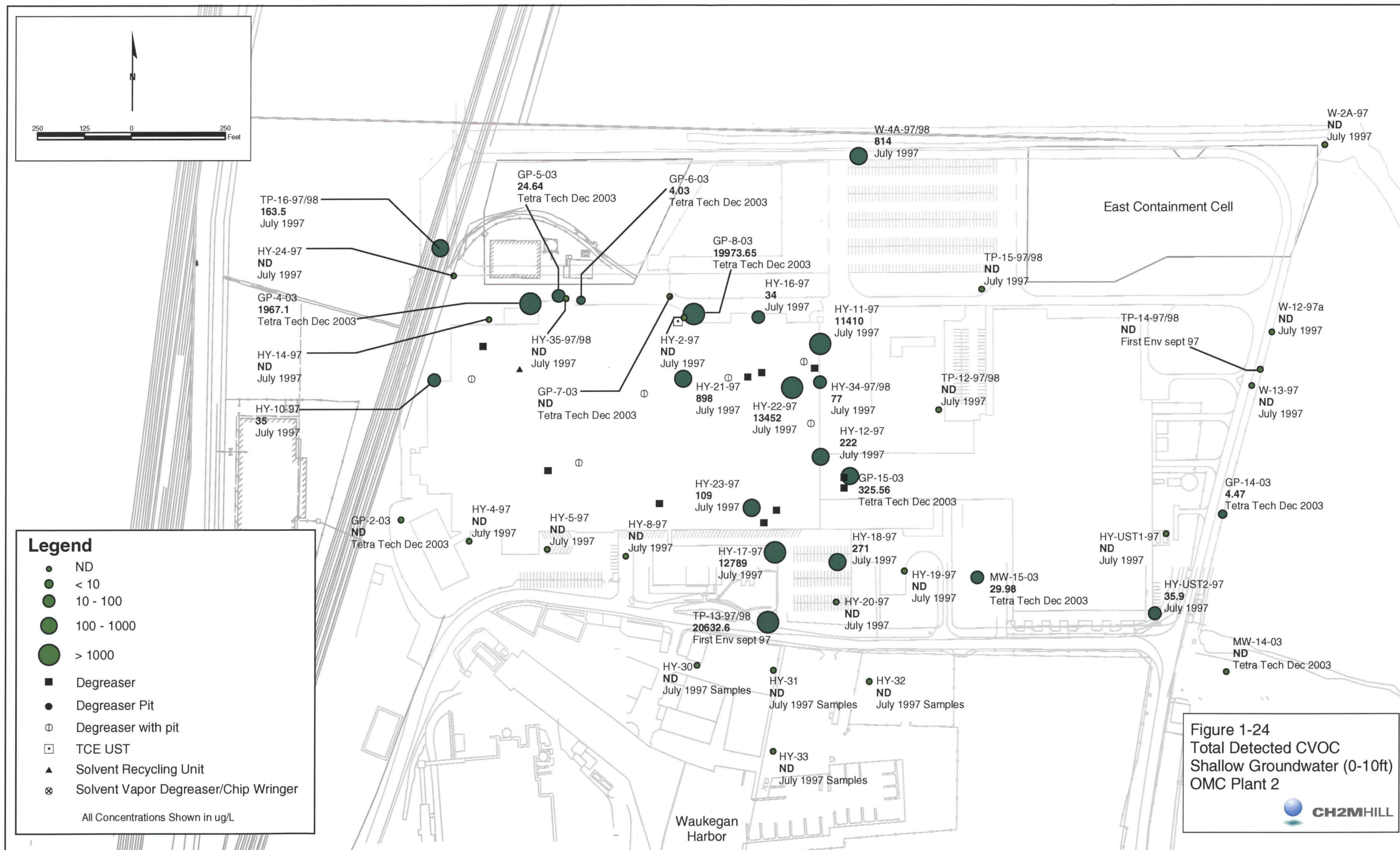


Figure 1-22.1  
Total Detected PCB Concentrations  
Shallow Soil(2-4 Feet)  
OMC Plant 2

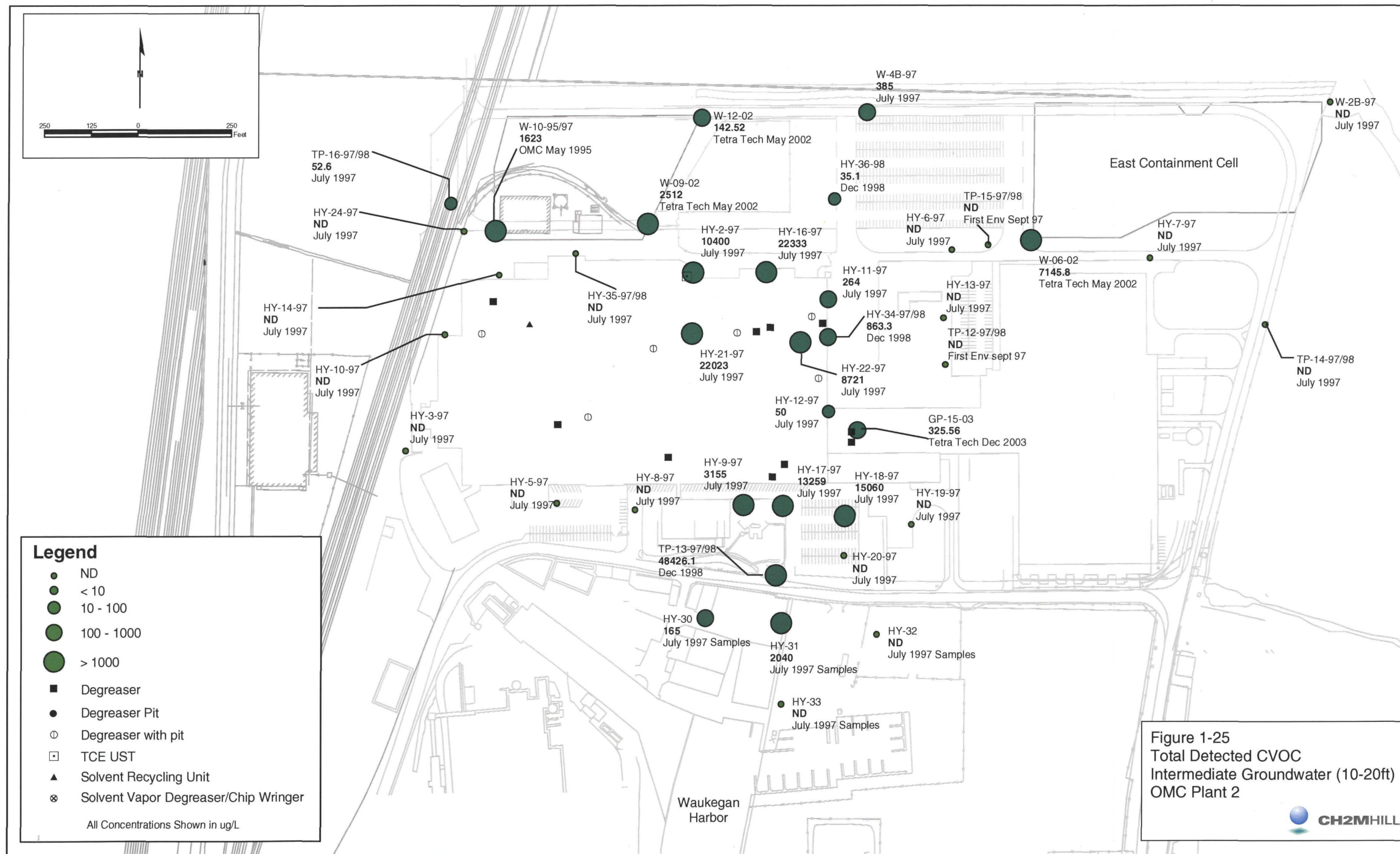




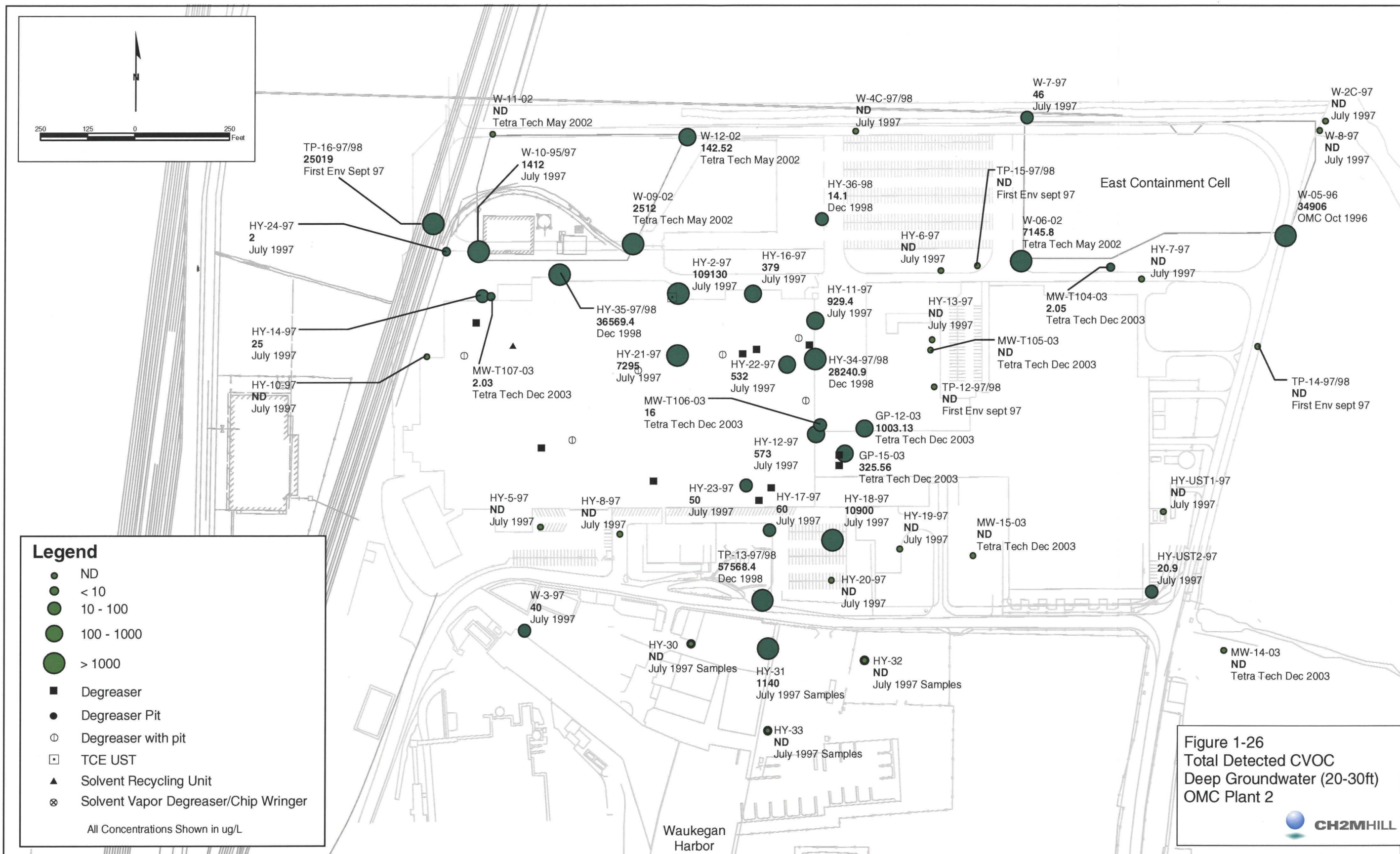














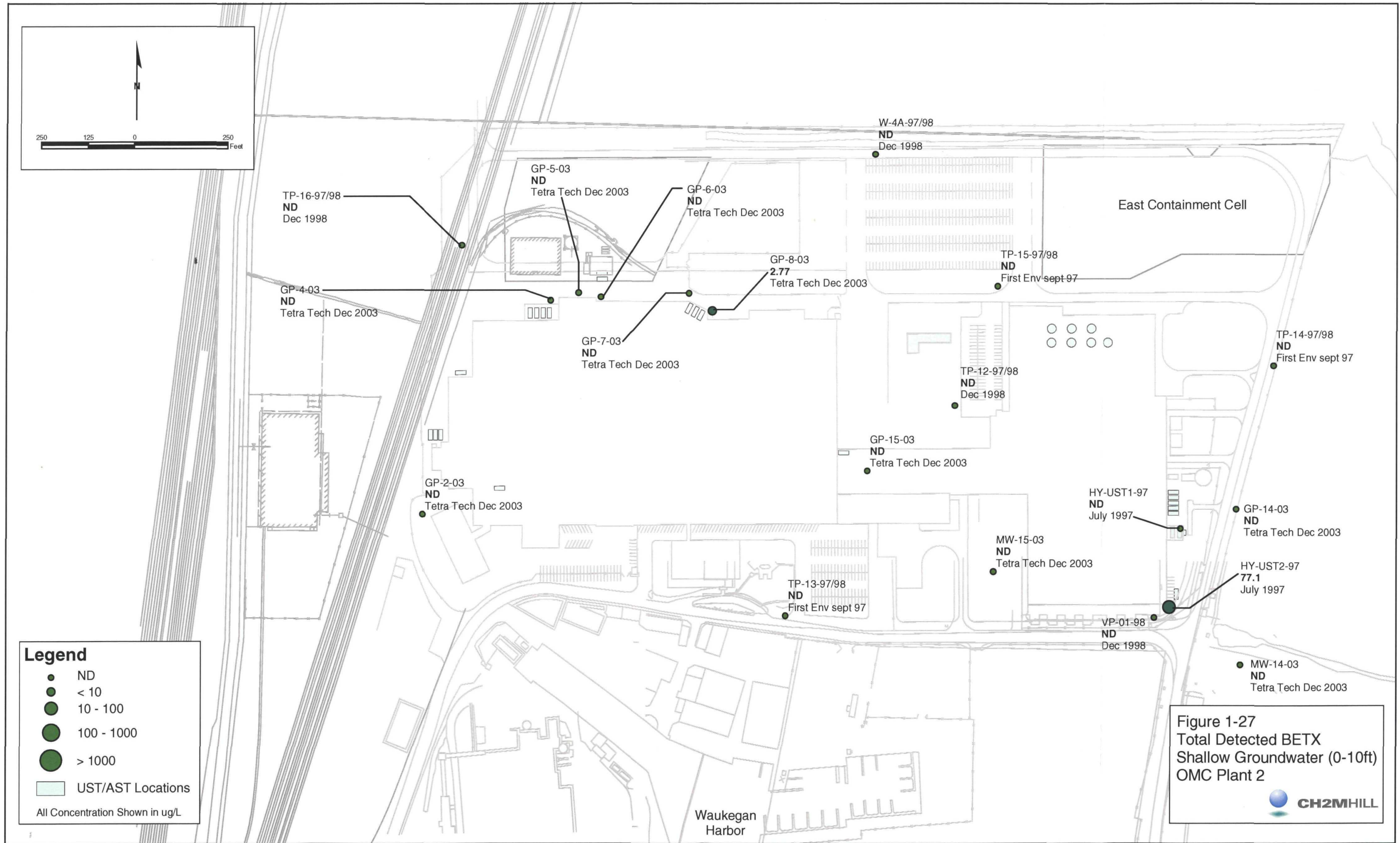
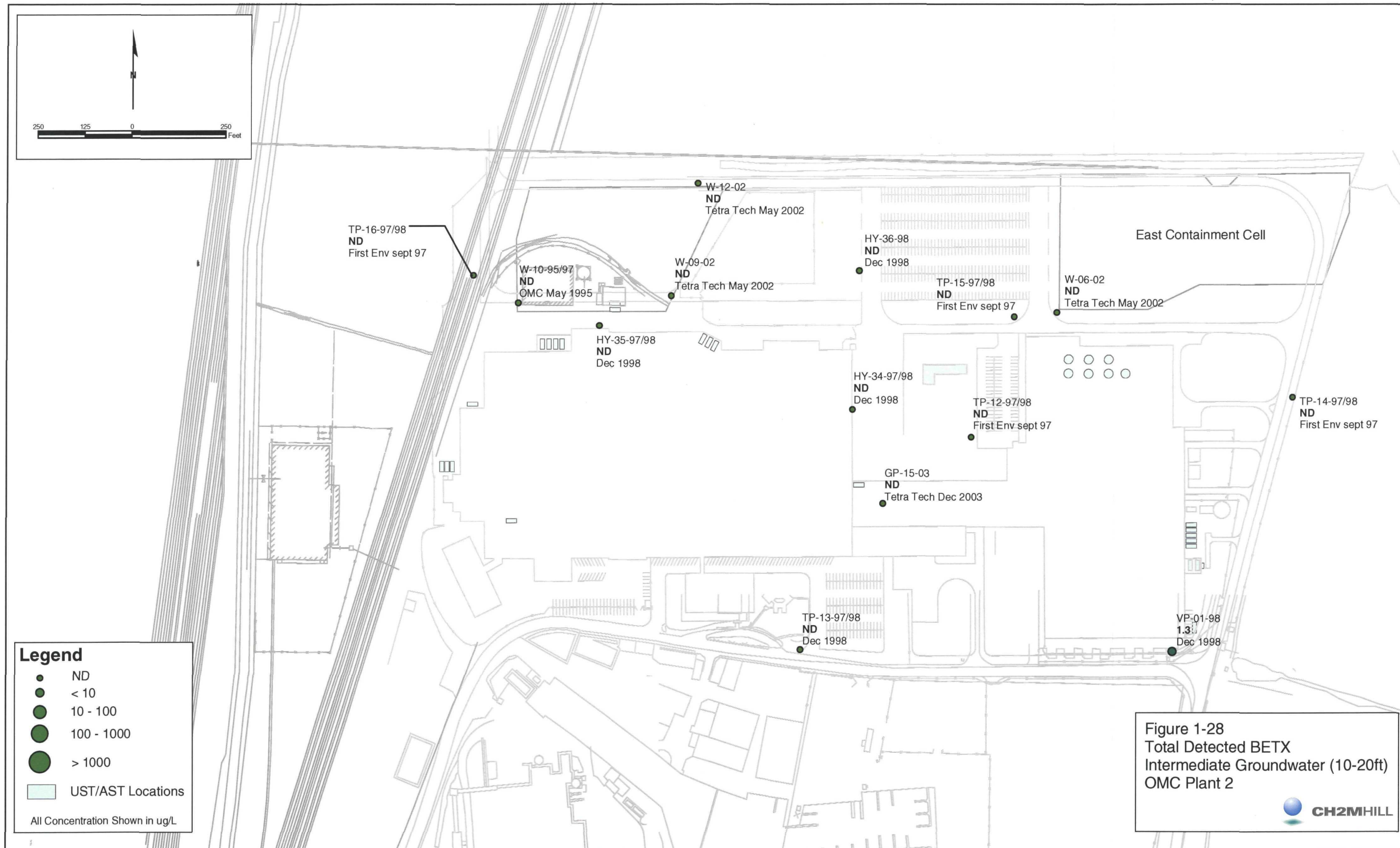


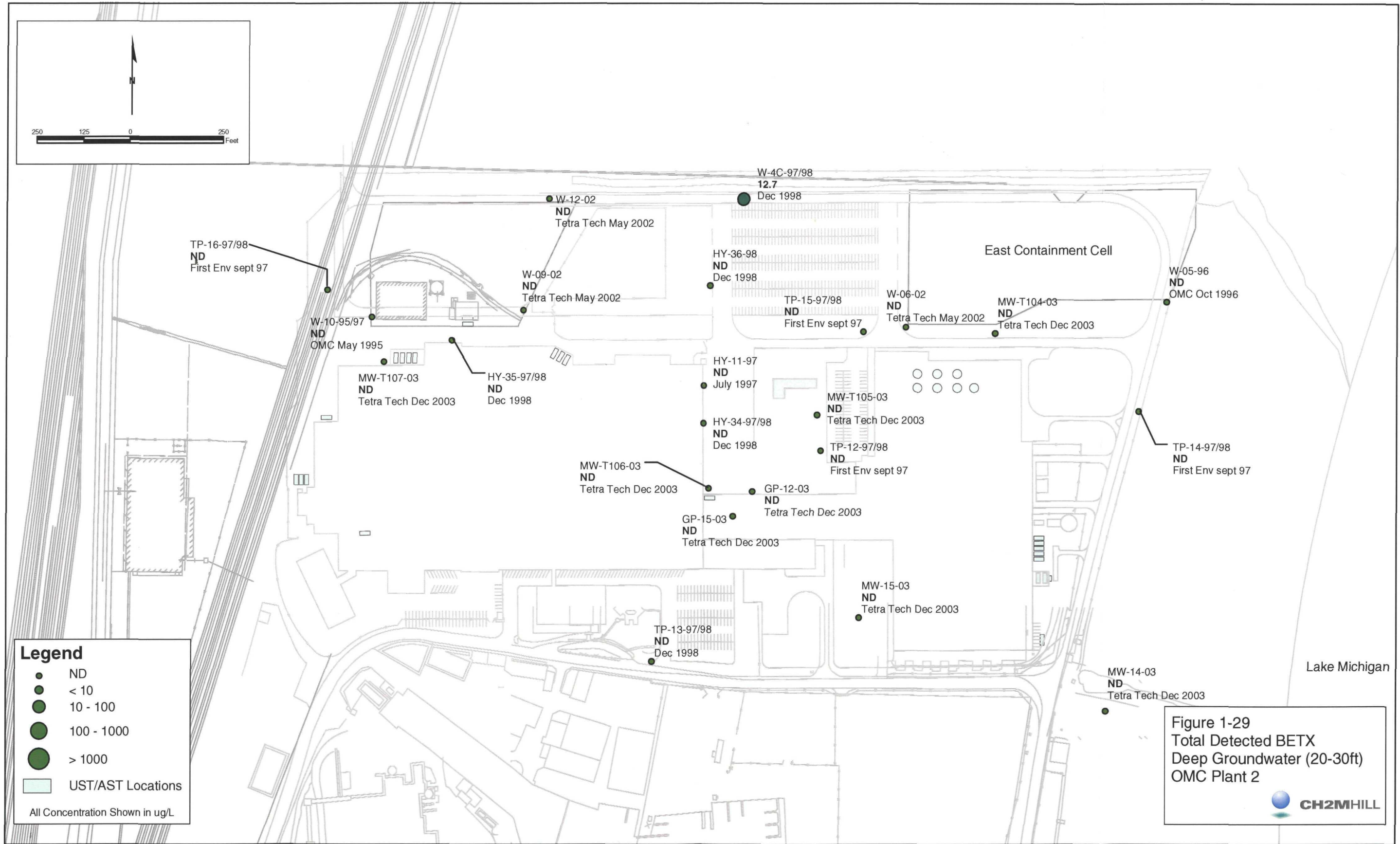
Figure 1-27  
Total Detected BETX  
Shallow Groundwater (0-10ft)  
OMC Plant 2

**CH2MHILL**









## Sample Network Rationale

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### 2.1 Project Objective and Approach

The field investigation has been designed to evaluate the impacts of OMC's historical operations and to verify and refine the extent and levels of residual contamination in the building materials in Plant 2, and surface soil, subsurface soil, and groundwater. OMC and USEPA have conducted multiple investigations at and in the vicinity of the site. The existing data from these investigations were evaluated and used to develop a conceptual model of the existing site conditions. Additional sampling has been identified to verify existing data, fill in data gaps, and to collect site-specific information needed to prepare the FS. Specific sampling objectives and approaches were developed for each medium based on the conceptual model and future land-use goals. Tables 2-1, 2-2, 2-3, and 2-4 provide an overview of the proposed sampling approach for the building materials, soil and sediment, groundwater, and soil gas and indoor air investigations, respectively.

### 2.2 Analytical Program

In developing the general chemical analytical program for the OMC site investigation, the project objectives and the following elements were considered:

- Identification of target compounds with respect to historic operations, chemical usage, and the results of previous investigations
- Determining appropriate and acceptable analytical methodology that meets the data quality objectives (DQOs), including site specific applicable or relevant and appropriate requirements (ARARs)
- Determining an effective analytical program with appropriate QA/QC requirements, such that site sampling location and frequency are optimized

#### 2.2.1 Contaminants of Concern

Contaminants of concern are defined as those most likely to contribute a risk as a result of exposure. Based on the results of the previous investigations conducted by OMC and USEPA, the primary contaminants at the site include VOCs (primarily CVOCs), SVOCs (mainly PAHs/CPAHs), PCBs, and metals (arsenic, barium, cadmium, chromium, and lead). Groundwater samples will also be analyzed to determine if conditions existing in the aquifer are conducive to natural attenuation of site-related compounds.

#### 2.2.2 Analytical Objectives

Previous investigations conducted by USEPA indicate that CVOCs and PCBs are present in soil and groundwater at levels greater than the Illinois Tier 1 Remediation Objectives in 35 IAC Subtitle G, Chapter I, Subchapter f, Part 742, Appendix B ("TACO"). The TACO

remedial objectives are consistent with the NCP required risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  ELCR and HI = 1. In general, the objectives of TACO are similar to USEPA Region 9 preliminary remediation goals (PRGs). The data generated during the RI and associated analytical program will be used to achieve these remediation objectives.

The extent of soil contamination will be based on the comparison of the analytical soil results with the Illinois TACO Tier I Soil Remediation Objectives (SROs) for residential properties (Section 742, Appendix B) based on City of Waukegan proposed future development plans. The soil remediation objective will be the lower of the criteria for exposure route value (i.e., ingestion or inhalation) or the groundwater ingestion exposure route value (Class I). If the lower exposure route value is less than the Acceptable Detection Limit (ADL), the ADL will be designated as the remediation objective. The Illinois TACO Tier I SROs for industrial/commercial properties and for residential properties for compounds that have been previously detected at the site are presented in Table 2-4.

The extent of groundwater contamination will be evaluated using the Illinois TACO Tier 1 Groundwater Remediation Objectives (GROs) for Class I aquifers (Section 742, Appendix B). The groundwater goals for compounds that have been previously detected at the site are also presented in Table 2-4.

### **2.2.3 Contract Laboratory Program Analysis**

Analytical laboratories in USEPA's Contract Laboratory Program (CLP) will be utilized to the extent possible. The use of CLP will be dependent on the media to be analyzed, the specific analyses, and the required turn-around times. The ability for the CLP to meet the specific media objectives will be discussed in the *Quality Assurance Project Plan* (QAPP).

Early in the week prior to the collection of samples requiring CLP analysis, USEPA's Regional Sample Control Center (RSCC) will be notified of the expected date of shipment and anticipated sampling duration, approximate number of samples to be collected, the sample matrices, the required analyses, and the analytical turn-around-times. CH2M HILL will collect the samples as scheduled and ship them to the CLP laboratories, identified by RSCC. The RSCC or Contract Laboratory Analytical Services Support (CLASS) personnel, as directed, will be notified of sample arrival on the day of shipment or at the start of the next business day.

Surface and subsurface soil samples (and associated QA/QC samples) will be submitted to the assigned CLP laboratory and analyzed for Target Compound List (TCL) VOCs, SVOCs, PCBs, and Target Analyte List (TAL) metals and cyanide.

Groundwater samples (and associated QA/QC samples) collected will be analyzed by the assigned CLP laboratory for TCL VOCs, SVOCs (including PAHs/CPAHs), and PCBs; total and dissolved TAL metals and cyanide (total); and general chemistry parameters (e.g., alkalinity, nitrate, nitrite, sulfate, sulfide, and total organic carbon).

The specific analyte lists and required reporting limits for the CLP-laboratory analyses will be presented in the QAPP. The analytical methods will be selected such that the quantitation limits for the contaminants of concern achieve the Illinois TACO Tier 1 remediation objectives or ADLs.

## 2.2.4 Independent Laboratory Analysis

It is anticipated that some of the samples cannot be submitted to the CLP and will need to be analyzed by an independent laboratory procured by CH2M HILL. These Special Analytical Services will likely include wipe samples, concrete core samples, NAPL samples, and analysis using the Synthetic Precipitation Leaching Procedure (SPLP) or Toxicity Characteristic Leaching Procedure (TCLP). Selected soil samples will be analyzed for TCLP metals, VOCs, SVOCs, and pesticides for the purpose of characterizing soils for offsite disposal. It is also anticipated the independent laboratories will be used to analyze soil samples for the geotechnical characteristics (e.g., grain size, porosity, bulk density, moisture content) and for soil oxidant demand that will be used evaluate transport characteristics and remedial technologies. The specific media, numbers of samples, and the method requirements for the analyses conducted by these independent offsite laboratory(ies) will be discussed in the QAPP.

## 2.3 OMC Plant 2 Building Materials Investigation

The overall objective for sampling the plant building materials is to evaluate material handling and disposal options, and not to evaluate the extent of contamination. PCB contamination has been identified in the Old Die Cast, Parts Storage, and Metal Working Areas during the discovery and removal activities conducted by USEPA (see Figure 1-11). The sampling and objectives for the different types of building materials are discussed below.

### 2.3.1 Metal Structures and Piping

Wipe sampling of metal and other nonporous surfaces (defined within TSCA [40 CFR 761.3] as a smooth, unpainted solid surface that limits penetration of liquid containing PCBs beyond the immediate surface) for PCBs will be conducted to determine whether decontamination is necessary and, if contaminated (i.e., above  $10 \mu\text{g}/100 \text{ cm}^2$ ), the type of thermal treatment or disposal that may be required. It is anticipated that the majority of nonporous surfaces in the building will be unpainted metal. The number of wipe samples will be limited to that which is sufficient to determine the general proportion of metal that will require decontamination, treatment, or to determine the type of landfill for offsite disposal.

Disposal of metal structures and piping will be conducted based on the following requirements:

#### **PCB Wipe Sample Concentrations $< 10 \mu\text{g}/100 \text{ cm}^2$**

- If the wipe samples collected from unpainted metal structures or piping contain PCB concentrations less than  $10 \mu\text{g}/100 \text{ cm}^2$  the metal can be sold as scrap without treatment or disposal requirements.
- If the wipe samples collected from painted metal structures or piping that contain no other indications of PCB contamination (i.e., no visible oily film) contain PCB concentrations less than  $10 \mu\text{g}/100 \text{ cm}^2$  the metal can be sold as scrap without treatment or disposal requirements.

**PCB Wipe Sample Concentrations  $>10 \mu\text{g}/100 \text{ cm}^2$  and  $< 100 \mu\text{g}/100 \text{ cm}^2$** 

- If the wipe samples collected from metal structures or piping contain PCB concentrations less than  $100 \mu\text{g}/100\text{cm}^2$  and greater than  $10 \mu\text{g}/100\text{cm}^2$  (40 CFR 761.61 (a)(5)(ii)(B)(1)) the scrap can be smelted directly in a smelter in compliance with 40 CFR 761.72 or disposed of in a RCRA Subtitle D solid waste landfill (40 CFR (a)(5)(ii)(B)(1)).

**PCB Wipe Sample Concentrations  $>100 \mu\text{g}/100 \text{ cm}^2$** 

- If the wipe samples collected from metal structures or piping contain PCB concentrations greater than  $100 \mu\text{g}/100\text{cm}^2$  the scrap must be thermally treated, per 40 CFR 761.61(a)(5)(ii)(B)(2), in a scrap metal recovery oven in compliance with 40 CFR 761.72 or disposed of in a RCRA Subtitle C hazardous waste landfill or a TSCA chemical waste landfill (40 CFR (a)(5)(ii)(B)(2)).
- In addition, metal structures and piping may be decontaminated on-site prior to sale as scrap to reduce PCB concentrations to below  $100 \mu\text{g}/100\text{cm}^2$ .

The exact locations of the wipe samples will be determined during site reconnaissance at the start of the field investigation. During this activity the unpainted overhead piping, metal girders and other unpainted metal surfaces in the Old Die Cast, Parts Storage, and Metal Working Areas (i.e., the areas where PCB contamination were previously identified) will be sketched on a facility map. A photographic record will also be made of the nonporous surfaces. Evidence of visual contamination, such as the presence of an oily film, will be noted on the sketch to allow later correlation to PCB wipe results. Wipe samples will be collected from 50 random sections of these nonporous surfaces. In addition, five wipe samples from the most visually contaminated nonporous surfaces will be collected to evaluate the potentially "worst case" conditions. The number of wipe samples may be adjusted downward based on the results of the reconnaissance survey if a relatively small percentage of metal surfaces are unpainted.

**2.3.2 Porous Surfaces Other Than Floors**

Wipe samples from porous surfaces (defined within TSCA [40 CFR 761.3] as "...any surface that allows PCBs to penetrate or pass into itself including, but not limited to, paint or coating on metal; corroded metal; ..."), such as concrete block walls, painted metal walls, painted piping, and painted girders that are not visibly contaminated, will be collected and analyzed for PCBs to confirm that concentrations are less than  $10 \mu\text{g}/100 \text{ cm}^2$ .

PCB concentrations detected in wipe samples will be used to determine appropriate handling and disposal of porous wall materials summarized below:

**PCB Wipe Sample Concentrations  $< 10 \mu\text{g}/100 \text{ cm}^2$** 

- Walls with PCB concentrations less than  $10 \mu\text{g}/100 \text{ cm}^2$  detected in wipe samples will be considered uncontaminated and no additional samples will be collected (40 CFR 761. Wall materials will be disposed of in a RCRA Subtitle D solid waste landfill or potentially considered for onsite disposal.

### PCB Wipe Sample Concentrations > 10 µg/100 cm<sup>2</sup>

- Walls with PCB concentrations greater than 10 µg/100 cm<sup>2</sup> detected in wipe samples will be core sampled if concrete or paint chips will be sampled if the surface is metal. Core or chip samples will be collected to determine disposal requirements for this material. Walls with core or chip sample PCB concentrations greater than 50 mg/kg will be disposed of in a RCRA Subtitle C hazardous waste landfill or a TSCA chemical waste landfill. Walls with core or chip sample PCB concentrations less than 50 mg/kg will be disposed of in a RCRA Subtitle D solid waste landfill or considered for onsite disposal.

The locations for the wipe samples will be determined during the site reconnaissance at the start of the field investigation. During the reconnaissance the makeup (i.e., porous or nonporous surface) and locations of the porous interior walls in the Old Die Cast, Parts Storage, and Metal Working Areas (i.e., the areas where PCB contamination were previously identified) will be identified on a facility map. Evidence of visual contamination, such as the presence of an oily film, will be noted on the sketch to allow later correlation to PCB wipe results. A photographic record will also be made of the porous surfaces. Wipe samples will be collected from 50 random locations. The number of wipe samples may be adjusted based on the results of the reconnaissance survey.

Concrete cores will be collected from concrete porous surfaces that are visibly contaminated or exceed the wipe sample criterion of 10 µg/100 cm<sup>2</sup>. The PCB results from the core samples will be compared to the 50-mg/kg TSCA disposal criteria to determine the disposal requirements and whether decontamination of walls is cost-effective prior to offsite disposal. Sampling will be sufficient only to determine the general proportion of concrete walls that will require disposal in a Subtitle D landfill versus disposal in a Subtitle C or TSCA chemical waste landfill. It is anticipated that core samples will be collected from 10 locations.

### 2.3.3 Porous Floor Surfaces

Limited concrete core samples will be collected and analyzed to determine how deeply PCBs may have penetrated into the floors, the disposal requirements for the concrete, and the potential for residual PCBs and metals to leach from the concrete. Concrete core samples (including different depth intervals at each location) will be collected and analyzed for PCBs. The results will be compared to the 50-mg/kg TSCA limit to determine the general proportion of the concrete in the Old Die Cast, Parts Storage, and Metal Working Areas that will require disposal in a Subtitle D landfill versus disposal in a Subtitle C or TSCA chemical waste landfill.

A site reconnaissance survey, including a photographic record of the building floors, will be performed at the start of the field investigation. During this activity the condition of the floors in the Old Die Cast, Parts Storage, and Metal Working Areas will be described on a facility map. Evidence of visual contamination, such as the presence of dark oily staining, will be noted on the sketch to allow later correlation to PCB core sample results.

The specific areas of floor sampling are presented in Figure 2-1, and the specific analyses associated with each area are provided in Table 2-1. Five randomly-located core samples will be collected from each of the Old Die Cast Area and Parts Storage Area, and 10 samples will be collected from the Metal Working Area. The sample locations presented in Figure 2-1 were selected using a random sampling scheme. A 100-foot grid, with grid lines



oriented in the north-south and east-west directions were overlain over the three areas and each grid node was numbered and the sampling locations were selected using a random number generator. In addition, one core location will be sampled in the northwest corner of the Chemical Storage Building and the New Die Cast Area where previous wipe sample concentrations exceeded  $10\text{ }\mu\text{g}/100\text{ cm}^2$  (see Figure 2-1).

One core sample from the Old Die Cast, Parts Storage, and Metal Working Areas and one core sample from the plating room (four samples, total) will also be analyzed for total metals and cyanide (Figure 2-1). These samples will also be analyzed using the Synthetic Precipitation Leaching Procedure (SPLP) to determine the leachability of PCBs and metals in the concrete under a potential remedial alternative, which may include the option of leaving the concrete onsite. The SPLP results of the core samples will be compared against Safe Water Drinking Act Maximum Contaminant Levels (MCLs) or Illinois TACO Groundwater Remediation Objectives (for Class I aquifers) to evaluate the potential impacts resulting from contaminants leaching from the concrete in the event that it is left in place.

### **2.3.4 Sanitary and Storm Sewers**

Sanitary and storm sewer lines outside of the main building will be tested to verify their location and that they are no longer connected to Waukegan Harbor. Selected sanitary sewer lines beneath the western portion of Plant 2 (e.g., the Metal Working Area) will also be tested. The PCB contamination in former Slip 3, Waukegan Harbor, and on the northern part of the property (i.e., North Ditch, Oval Lagoon, Crescent Ditch and the parking lot) have been attributed to discharges of hydraulic fluids from Plant 2. Historical information indicate that piping beneath the western end of Plant 2 has not been formally decommissioned or decontaminated, that several drains that discharged to sanitary sewers were plugged and that the storm sewers extending into the parking lots beyond the limits of the building were decommissioned. The testing will be conducted to verify that the sanitary and storm sewers beneath Plant 2 no longer provide a direct pathway for releases to Waukegan Harbor or to Lake Michigan via the North Ditch.

## **2.4 Soil and Sediment Investigation**

### **2.4.1 Investigation Objectives**

The overall RI objective for soil and sediment sampling is to define the nature and extent of contamination, to support the assessment of potential risk to human health and the environment, and to determine whether remedial actions are necessary. The data from the previous investigations conducted provide a relatively well defined picture of soil and sediment contamination outside of the building and an extensive soil investigation is not necessary. A limited and focused field investigation will be conducted to fill in data gaps identified based on evaluation of the existing data. The key elements in developing the sampling approach for the soil and sediment include:

- Sediment in the North Ditch contain PCB concentrations above the likely remedial action objective (for Waukegan Harbor the remedial action level for PCB is  $1\text{ mg/kg}$  at any single location and a surface-weighted average concentration of  $0.25\text{ mg/kg}$ ). Further sampling is not needed because the sediment volume is relatively small. For the purpose of the FS, it



will be assumed that all of the North Ditch sediments will require remediation. A field reconnaissance survey will be performed to identify the volume of sediment in the North Ditch (measuring width and thickness of sediments along multiple transects).

- The nature and extent of soil contamination below the building is limited to a thin, saturated thickness (typically, about 4 feet), and can be adequately characterized at selected borings used to delineate groundwater contamination.
- The existing data indicate that elevated concentrations of PCB and CVOCs in the soil are likely to pose risks to human health that exceed the acceptable risk range of  $1 \times 10^{-4}$  excess lifetime cancer risk (ELCR) and the Hazard Index (HI) of 1. As a result, it may be possible to streamline the risk assessment to an assessment of potential exposure pathways and a qualitative comparison to Illinois TACO Tier I Remediation Objectives or USEPA's preliminary remedial goals, rather than quantifying the risk. The need for a quantitative risk assessment will be reevaluated upon completion of the RI.

A soil investigation will be conducted in conjunction with the groundwater investigation. The specific objectives of the limited soil investigation will be to:

- Define eastern contamination (CPAH and PCB) boundary of Former Die Cast UST/AST area located east of Plant 2
- Characterize the soils in the vicinity of PCB AST area and parking lot areas north of Plant 2 (between the two containment cells) sufficiently to evaluate the potential for direct contact risk.
- Verify that soils in the uncovered grassy areas surrounding the corporate office buildings south of Plant 2 will not pose direct contact risk related to site-related contaminants.
- Determine contaminant concentrations in soil beneath building at selected groundwater investigation locations.
- Collect soil property data to evaluate contaminant fate and transport and remedial technologies.

## 2.4.2 Sampling Approach

Soil samples from under the building will be collected over the 0- to 4-foot sampling interval and will be analyzed for VOCs and PCBs. Random unsaturated soil samples beneath the buildings will also be analyzed for TAL metals and cyanide. The sample locations will be coincident with the groundwater investigation locations.

Surface soil samples from locations outside of the building will be collected using direct push technology from the 0- to 6-inch interval and 2-foot interval above the water table (estimated depth of about 4 feet). Additional sample intervals may be collected based on visual or olfactory evidence of contamination or high levels of organic vapors, as indicated by a photoionization detector (PID) or equivalent instrument. These unsaturated soil samples will be analyzed for VOCs, SVOCs (including PAHs/CPAHs), and PCBs.

In addition, unsaturated and saturated soil samples will be collected from selected groundwater investigation locations and analyzed for total organic carbon for evaluation of contaminant migration and testing of geotechnical properties (e.g., porosity, bulk density, grain size, and moisture content) and soil oxidant demand for evaluation of remedial alternatives.

### **2.4.3 Sample Locations**

The soil sample locations inside and outside of the building and the specific analyses to meet each are the objectives are discussed below and are provided in Table 2-2.

#### **2.4.3.1 Former Die Cast UST/AST Area**

The soil sample locations to define the eastern extent of contamination (CPAH and PCB) of Former Die Cast UST/AST area located east of Plant 2 are presented in Figure 2-2 and 2-2.1. The sample locations are based on the previous surface soil sample locations containing PCB concentrations exceeding 1 mg/kg. Four borings will be located immediately east of the access road spaced about 100 feet apart. In addition 2 borings will be located in the southeastern corner of the site to define the southern PCB contamination boundary.

Four additional borings will be conducted to the north following the north-south access road (see Figure 2-2). The data from these locations will help to determine if site activities have potentially impacted the beach area. The preliminary results from these locations will be requested with an expedited turn around time from the laboratory (7 days). Additional sample locations will be stepped out eastward at 100-foot intervals from locations with PCB concentrations exceeding the 1 ppm criteria.

#### **2.4.3.2 PCB Area North of the Plant**

The area between the two containment cells and surrounding the former PCB AST Tank Farm will also be investigated to determine the extent of contamination relative to the 1 mg/kg PCB goal. The 34 sampling locations presented in Figure 2-3 are based on a 200-foot grid interval with a tighter spacing of 100 feet around the Chip Room, the chip loading dock area and the former tank farm where PCBs have been previously detected.

#### **2.4.3.3 Grassy Area Surrounding Corporate Building**

The areas south and east of the Corporate Building will be investigated to determine if soil contamination exists south of the non-paved areas south of the plant. Membrane Interface Probes (MIPs) will be implemented at eight soil sample locations shown in Figure 2-4. The use of the MIPs system will provide lithologic information (soil conductivity) and allow for rapid field screening to determine the presence of VOCs (in soil and groundwater) at discrete subsurface intervals (typically 1- to 2-foot intervals). These preliminary locations, based on previous investigations, have indicated high VOC concentrations in groundwater within this general area. Soil samples will be collected from five locations based on the MIPs investigation.

#### **2.4.3.4 Beneath Plant 2**

Sampling locations beneath the plant will help to confirm and define the nature and extent of soil contamination, particularly TCE contamination beneath the building. The initial MIPs locations in Plant 2 are based on a 200-foot grid with a tighter, focused, probe locations completed with 100-foot spacing within areas of known or suspected contamination

(Figure 2-4). These initial MIPs locations were selected based on TCE concentrations previously detected in groundwater samples and till elevations. Analytical results from previous investigations indicate TCE contamination greater than 10 µg/L within the Metal Working Area and areas outside the building near the northwestern portions of the site and areas just south and west of the Corporate Building. It is possible that areas containing TCE concentrations greater than 10 µg/L may include “free product” (i.e., NAPL). The MIPs investigation will focus on defining TCE contamination within and near these areas to determine the continuity of these high concentration areas. The probe locations may be modified based on the MIPs results.

Soil samples from beneath Plant 2 will be collected from borings located six feet or less from the MIPs locations. The soils sample locations will be selected based on evidence of contamination (e.g., visual, olfactory and MIP results) and as confirmatory samples (about 10 percent of locations) for correlation to MIP results. Confirmation samples will be collected to represent both low and high concentration areas. Initially, the MIPs confirmation samples will be collected from less contaminated areas to provide a baseline for future sampling. The results of the soil samples will be used to correlate the MIPs response to soil concentration. Saturated soil samples will also be collected from 10 locations in areas of elevated CVOC concentrations for analysis of contaminant concentrations and physical parameters used in evaluating remedial technologies (e.g., porosity, bulk density, grain size, and moisture content and soil oxidant demand).

#### **2.4.3.5 Soil Sampling from New Monitoring Well Borings**

Soil samples will be collected from borings at the proposed new monitoring wells locations (estimated 10 locations) outside the building. The approximate new monitoring well locations, as shown on Figure 2-4, were based on data from previous site investigations. The actual monitoring well locations may be modified based on the MIPs investigation results. At each new monitoring well location three soil samples will be collected from the unsaturated zone, top of aquifer and bottom of aquifer. These samples will be collected to evaluate transport properties of the unsaturated zone and groundwater flow and transport characteristics of the aquifer.

## **2.5 Groundwater Investigation**

### **2.5.1 Investigation Objective**

The overall RI objective for groundwater sampling is to define the nature and extent of contamination, to support the assessment of potential risk to human health and the environment, to determine whether remedial actions are necessary and, if so, to allow evaluation of remedial alternatives. The nature and extent of groundwater contamination has been relatively well defined based on the data from the previous investigations. A focused field investigation will be conducted to:

- Verify current groundwater flow and water quality conditions indicated by existing data
- Define the extent of contamination to the south, around “hot spot” areas and beneath portions of the plant that have no data
- Define the extent of NAPL

## 2.5.2 Sampling Approach

The groundwater investigation will be conducted using direct push technologies. The proposed approach is to use MIPs to get vertical delineation of contamination. The use of the MIPs system will provide lithologic information (soil conductivity) and allow for rapid field screening to determine the presence of VOCs (in soil and groundwater) at discrete subsurface intervals (1- to 2-foot intervals). Because the detector in the MIP system will provide a response value and not direct groundwater concentration, groundwater grab samples at selected locations will be collected and sent to an offsite laboratory for VOC analysis. The results of the groundwater samples will be used to correlate the MIPs response to a VOC concentration. A sufficient number of groundwater grab samples (about 10 percent of the locations) will be collected to represent both low and high concentration areas.

Groundwater grab samples from beneath the building will be collected and analyzed for VOCs. In addition, samples in the vicinity of the plating/foundry areas will also be analyzed for hexavalent chromium and total cyanide and filtered for dissolved metals analysis.

If NAPL is encountered, samples will be collected using a Teflon or stainless steel bailer or a peristaltic pump with Teflon tubing. The sampling will be conducted in such a manner as to minimize the amount of water collected when filling the sample containers. NAPL samples will be analyzed for VOCs and PCBs.

The MIP data will be used to determine locations (estimated 5 locations) for “micro wells” to be installed within the building and locations for permanent monitoring well locations (estimated 10 locations) outside of the building and their screened intervals. Water level measurements and groundwater samples will be collected from new and existing wells (four monitoring wells were sampled by USEPA in 2002 and 13 wells were sampled by USEPA in 2003). The water samples collected from the monitoring wells will be analyzed for VOCs, SVOCs (including PAHs/CPAHs), PCBs, cyanide, total and dissolved metals, and natural attenuation parameters.

## 2.5.3 Sample Locations

The groundwater sample locations and the specific analyses to meet each are the objectives are discussed below and are provided in Table 2-3.

### 2.5.3.1 Existing Monitoring Wells

Based on the recent sampling conducted by OMC and USEPA it is estimated that 23 monitoring wells still exist at the site and can be used to evaluate current groundwater conditions. The locations of these monitoring well locations are shown on Figure 2-4 and well construction information is presented in Table 2-5. The location and suitability of the wells for use in the groundwater investigation will be field verified as part of the site reconnaissance conducted prior to the start of sampling activities. Low flow sampling will be used to collect groundwater samples from 6 shallow (0-10 feet), 6 intermediate (10-20 feet), and 11 deep (20 to 30 feet) zone monitoring wells. The groundwater sampling event will verify water quality conditions identified by previous investigations, fill in data gaps, determine hydraulic gradients and groundwater velocities, and confirm the nature and extent of groundwater contamination by previous investigations. In addition, field measurements and natural attenuation parameters will be collected at each location.

### **2.5.3.2 New Monitoring Wells Outside Building**

Permanent monitoring wells will be installed at an estimated 10 locations outside the building to monitor groundwater contamination observed in previous sampling events and potential source areas, potential groundwater discharges to Waukegan Harbor, and to determine groundwater flow onto the site. The initial monitoring well locations are provided on Figure 2-4. The actual locations of these wells will be determined from MIPs investigations. These monitoring well locations will include nested wells, a shallow and deep zone well, at similar depths as to monitor the shallow zone (0 to 10 feet) and deeper zone (20 to 30 feet) groundwater. A low-flow groundwater sample will be collected from the wells at each location for a total of 20 groundwater samples.

### **2.5.3.3 New Monitoring Wells Within Building**

Five “micro” monitoring wells will be installed within the building or near the outside the building at locations based on results of the MIPs investigations. These temporary locations will be selected to monitor the TCE groundwater plume and boundaries. At each of the five locations nested wells will be installed. Each well nest will monitor the shallow water table (0 to 10 feet) and deeper (20 to 30 feet) zone and be sampled using low flow sampling methods. Groundwater samples will be collected from both wells at each location for a total of 10 groundwater samples.

## **2.6 Soil Gas and Indoor Air Investigations**

### **2.6.1 Investigation Objective**

Soil gas (volatilization from soil and groundwater) above the chlorinated solvent plume will pose an unacceptable risk to residents or workers in any future buildings constructed within the footprint of the existing building (assuming no further action for VOC remediation in soil and/or groundwater). Therefore, the construction of any buildings on the site would need to include controls to mitigate potential vapor intrusion. Vapor sampling from beneath the building is not proposed because: 1) it is likely that risk-based concentrations are exceeded, and 2) results will not be representative of future conditions when the building no longer exists and potential soil or groundwater remedial activities have been implemented.

The data from the intermediate and deep monitoring wells indicate that the chlorinated solvent plume extends to the south beyond the OMC boundaries toward Larsen Marine. A soil gas investigation will be conducted to determine if volatilization from the groundwater plume may cause a potential inhalation risk to human health. A focused investigation will be conducted to:

- Characterize the CVOC levels in the soil gas above the chlorinated solvent plume south of the OMC site.
- Determine CVOC concentrations in ambient air within the buildings currently utilized by Larsen Marine that may be impacted by volatilization from the groundwater plume.

### **2.6.2 Sampling Approach**

Soil gas samples will be collected from the unsaturated zone at locations south of the OMC site in the vicinity of Larsen Marine. Direct push technologies will be used to install temporary gas probes for the collection of vapor into Summa canisters. The soil gas samples will be sent to an offsite laboratory to be analyzed for VOCs.

In addition to the soil gas samples, indoor air samples will be collected from the Larsen Marine buildings. Over an 8-hour period, samples from within the each of the main buildings on the Larsen Marine property and one background sample will be collected using Summa canisters and analyzed for VOCs. The canisters will be set up to collect air samples during nonworking hours.

### **2.6.3 Sample Locations**

The soil gas locations and the specific analyses to meet the objectives are provided in Table 2-4. Soil gas samples will be collected from five locations in the vicinity of Larsen Marine (see Figure 2-5). These initial locations were based on the estimated location of the groundwater plume delineated based on the existing CVOC data. The actual locations may be modified based on the MIPs investigation results. An additional five locations may be sampled to refine the delineation of elevated soil gas VOC levels.

**TABLE 2-1**  
Summary of Sample Locations and Rationale for Building Material Investigation  
OMC Plant 2

Overall Sampling Objective	Media	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (ft)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
Collect PCB data to evaluate material handling and disposal options of plant building materials.	Non-porous surfaces: unpainted metal structures and piping	Random locations within the Old Die Cast Area, Parts Storage Area, and the Metal Working Area	Wipe samples	50 random locations 5 visually contaminated locations	Surface	55	TCL PCBs	To determine whether these nonporous media are contaminated and will need to be decontaminated, and, if contaminated, the type of thermal treatment or disposal required.
	Porous surfaces other than floors	Random locations within the Old Die Cast Area, Parts Storage Area, and the Metal Working Area	Wipe samples	50 random locations 5 visually contaminated locations	Surface	55	TCL PCBs	To determine the relative proportion of porous surfaces that are contaminated (i.e., PCB concentration > 10 µg/100 cm <sup>2</sup> ) and to determine if further bulk sampling is needed to determine disposal requirements.
		Visually contaminated areas or where results from wipe samples > 100 µg/100 cm <sup>2</sup>	Concrete core samples	5 core locations	0–4 in.	5 <sup>b</sup>	TCL PCBs	To determine if contaminated materials contain PCB concentrations > the TSCA disposal criteria of 50 mg/kg.
	Porous floor surfaces	Random locations within the Old Die Cast Area, Parts Storage Area, and the Metal Working Area	Concrete core samples	5 random locations in Old Die Cast Area 5 random location in Parts Storage Area 10 random locations in Metal Working Area	0–4 in.	20 <sup>b</sup>	TCL PCBs	To determine if contaminated materials contain PCB concentrations > the TSCA disposal criteria of 50 mg/kg.

**TABLE 2-1**  
Summary of Sample Locations and Rationale for Building Material Investigation  
OMC Plant 2

Overall Sampling Objective	Media	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (ft)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
		Northwest corner of Chemical Storage Building	Concrete core samples	1	0–4 in.	1	TCL PCBs	Previous samples from this area contained PCB concentrations > 10 µg/100 cm <sup>2</sup> in wipe samples. Core samples will be analyzed to determine if contaminated materials contain PCB concentrations > the TSCA disposal criteria of 50 mg/kg.
		Northwest corner of New Die Cast Area	Concrete core samples	1	0–4 in.	1	TCL PCBs	Previous samples from this area contained PCB concentrations > 10 µg/100 cm <sup>2</sup> in wipe samples. Core samples will be analyzed to determine if contaminated materials contain PCB concentrations > the TSCA disposal criteria of 50 mg/kg.
		Random locations within the Old Die Cast Area, Parts Storage Area, and the Metal Working Area	Concrete core samples	1 from each area <sup>c</sup>	0–4 in.	3	TAL metals & cyanide (total) SPLP PCBs SPLP metals	Evaluate potential impacts of leaching from contaminated concrete to allow evaluation of onsite disposal alternatives.
		Plating Room	Concrete core samples	1	0–4 in.	1	TAL metals & cyanide (total) SPLP PCBs SPLP metals	Evaluate potential impacts of leaching from contaminated concrete to allow evaluation of onsite disposal alternatives.

Notes:

<sup>a</sup> Number of samples does not include quality control samples.

<sup>b</sup> The 4-in. cores may be subdivided into different depth intervals (0- to 1-in. and 3-to 4-in.) based on visual contamination.

<sup>c</sup> Sample will be collected from one of the random locations selected for PCB analysis.



**TABLE 2-2**  
Summary of Sample Locations and Rationale for Soil Investigation  
OMC Plant 2

Overall Sampling Objectives	Media	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (ft)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
Confirm the nature and extent of contamination identified by previous investigations. Fill data gaps. Collect geotechnical characteristics of the soils.	Unsaturated soils	Former Die Cast UST/AST Area and along access road adjacent to dune area east of the site	Direct push methods	6 locations around area 4 locations along north-south access road	0–6 in. 2-ft interval above water table	20	TCL VOCs TCL SVOCs <sup>b</sup> TCL PCBs	Define eastern contaminant boundary. Additional locations will be stepped out at 100-ft intervals based on results from initial locations.
	Unsaturated soils	PCB Area north of the Plant	Direct push methods	34	0–6 in. 2-ft interval above water table	68	TCL VOCs TCL SVOCs <sup>b</sup> TCL PCBs	Define limits of soil contamination in vicinity of PCB AST area and northern parking lot area.
	Unsaturated soils	Uncovered grassy area surrounding the Corporate Building	Direct push methods	5	0–6 in. 2-ft interval above water table	10	TCL VOCs TCL SVOCs <sup>b</sup> TCL PCBs	Determine if soil contamination exists in the nonpaved areas south of the plant. High VOC concentrations have been observed in the groundwater of this general area.
	Unsaturated and saturated soils	Selected locations in area of elevated groundwater contamination	Direct push methods	10	0–4 ft Top of aquifer Bottom of aquifer	30	TCL VOCs TCL PCBs TCL SVOCs <sup>b</sup> TOC Porosity Bulk Density Grain Size Moisture Content Soil Oxidant Demand	Determine contaminant concentrations in soil beneath the building to allow comparison against groundwater concentrations and to allow evaluation of remedial technologies.

**TABLE 2-2**  
Summary of Sample Locations and Rationale for Soil Investigation  
OMC Plant 2

Overall Sampling Objectives	Media	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (ft)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
	Unsaturated soils	Random samples beneath building	Direct push methods	7 to 10 random locations (estimated based on 10 percent of the MIPs locations)	0–4 ft	7 to 10	TCL VOCs TAL Metals & Cyanide <sup>c</sup>	Determine contaminant concentrations in soil beneath the building and to correlate MIPs response to concentrations in soil.
	Unsaturated and saturated soils	Samples from borings for new monitoring wells installed outside of the building	Hollow-stem augers/ split-spoon samplers	10	Unsaturated zone sample Top of aquifer Bottom of aquifer	30	Total Organic Carbon Grain Size Porosity Bulk Density	Samples will be collected to evaluate transport properties of the unsaturated zone and groundwater flow and the transport characteristics of the aquifer.

**Notes:**

<sup>a</sup> Number of samples does not include quality control samples.

<sup>b</sup> PAHs and CPAHs will be analyzed as part of the SVOC list.

<sup>c</sup> Soil samples taken near the plating/foundry areas will be analyzed for metals and cyanide.

TABLE 2-3

Summary of Sampling Locations and Rationale for Groundwater Investigation  
OMC Plant 2

Overall Sampling Objectives	Monitoring Point	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (feet)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
<p>Determine site-specific hydraulic gradients and groundwater velocities.</p> <p>Confirm the nature and extent of contamination identified by previous investigations.</p> <p>Fill data gaps.</p>	Temporary borehole	Randomly selected borings adjacent to MIPs locations	Discrete groundwater grab sample	7 to 10 random locations (estimated based on 10 percent of the MIPs locations)	Shallow Zone (0–10 ft) Intermediate Zone (10–20 ft) Deep Zone (20–30 ft)	21	TCL VOCs Cr <sup>6+</sup> , TAL metals (dissolved) & cyanide (total) <sup>b</sup> Note: If NAPL is encountered, samples will also be analyzed for TCL PCBs	Correlate MIPs response and CVOC groundwater concentrations.
	Existing monitoring wells <sup>c</sup>	Shallow (0–10 ft): W-2A, W-3, W-4A, W-12A, W-13, MW-14, MW-15  Intermediate (10–20 ft): W-2B, W-4B, W-12, W-06, W-10, W-09  Deep (20–30 ft): W-4C, W-05, W-7, W-11, W-4, MW-T101, MW-T104, MW-T105, MW-T106, MW-T107	Low flow sampling	23	6 shallow, 6 intermediate, 11 deep	23	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup>  Field analyses <sup>f</sup>	Verify water quality conditions identified by previous investigations.

TABLE 2-3

Summary of Sample Locations and Rationale for Groundwater Investigation  
OMC Plant 2

Overall Sampling Objectives	Monitoring Point	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (feet)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
	New monitoring wells	Southwestern corner of site near Chemical Storage Building	Low flow sampling	1	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	2	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup>  Field analyses <sup>f</sup>	Determine groundwater flow onto site from former OMC Plant 3.
		Northwestern portion of site	Low flow sampling	1	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	2	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup>  Field analyses <sup>f</sup>	TP-16 contained high VOC concentrations in the deep groundwater (25,019 µg/L). The source of contaminant concentrations in this area needs to be examined. The exact location for this well may be located west of the railroad.
		Outside of chip dock area	Low flow sampling	1	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	2	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>d</sup>  Field analyses <sup>e</sup>	Monitor contamination observed in HY-35 that previously contained high VOC concentrations in the deep groundwater (36,569.4 µg/L).

**TABLE 2-3**  
Summary of Sample Locations and Rationale for Groundwater Investigation  
OMC Plant 2

Overall Sampling Objectives	Monitoring Point	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (feet)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
		Outside of chip room	Low flow sampling	1	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	2	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup>  Field analyses <sup>f</sup>	Monitor contamination observed in HY-2 and GP-8 that previously contained high VOC concentrations in the groundwater.
		Parking lot between Old Die Cast Area and New Die Cast Area, south of former PCB ASTs	Low flow sampling	1	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	2	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup>  Field analyses <sup>f</sup>	Monitor contamination observed in HY-22 and HY-34 that previously contained high VOC concentrations in the groundwater. This location was also identified to potentially be a low spot in the till.
		Near Corporate Offices	Low flow sampling	2	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	4	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup>  Field analyses <sup>f</sup>	Monitor contamination observed in HY-18, HY-9, HY-17 and TP-13 that previously contained high VOC concentrations in the groundwater. This source of the contamination in this area is unknown.



**TABLE 2-3**

Summary of Sample Locations and Rationale for Groundwater Investigation  
OMC Plant 2

Overall Sampling Objectives	Monitoring Point	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (feet)	Number of Samples <sup>a</sup>	Analysis	Rationale behind Selection of Sampling Locations
		Larson Marine Property—near Slip 4	Low flow sampling	2	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	4	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup> Field analyses <sup>f</sup>	Groundwater contamination has not been observed in previous groundwater grab samples collected in this area. Based on groundwater flow data, this location may serve to monitor potential groundwater discharges to Waukegan Harbor.
		Within the building	Low flow sampling	5	2 well nests: shallow water table well (0–10 ft) deep well (20–30 ft)	10	TCL VOCs TCL SVOCs <sup>d</sup> TCL PCBs TAL metals (total and dissolved) & cyanide (total)  Natural attenuation parameters <sup>e</sup> Field analyses <sup>f</sup>	These locations will be selected based on the results of the MIPs investigation. These locations will be selected to monitor the contaminated groundwater plume under the building and will include high concentration areas as well as the plume boundaries.

Notes:

<sup>a</sup> Number of samples does not include quality control samples.

<sup>b</sup> Groundwater grab samples in the vicinity of the plating/foundry areas will be analyzed for dissolved metals, cyanide, and hexavalent chromium.

<sup>c</sup> Number of existing wells and condition will be determined during site reconnaissance.

<sup>d</sup> PAHs and CPAHs will be analyzed as part of the TCL SVOC list.

<sup>e</sup> Natural Attenuation Parameters include: methane, ethane, ethene, dissolved iron, total alkalinity, chloride, nitrate, nitrite, sulfate, sulfide, and total organic carbon.

<sup>f</sup> Field Analysis includes: water levels, temperature, pH, specific conductance, conductivity, dissolved oxygen, oxidation-reduction potential, and turbidity.

**TABLE 2-4**  
Summary of Sample Locations and Rationale for Soil Gas and Indoor Air Investigation  
OMC Plant 2

Overall Sampling Objective	Media	General Location Description	Collection Method	Number of Sampling Locations	Sample Depth (feet)	Number of Samples <sup>a</sup>	Analysis	Rational of Selection of Sampling Locations
Determine the nature of potential soil gas levels above the groundwater plume in the vicinity of Larsen Marine	Soil gas	Soil boring locations selected based on the plume boundaries in the vicinity of Larsen Marine	Collection of soil vapor samples from soil gas probes (with PRT adapters) using Summa canisters. Approximately 5 minutes of soil gas sampling per Summa canister.	5 to 10 <sup>b</sup>	From unsaturated zone (water table estimated to be about 5 feet bgs)	10	TO-15 SIM VOCs	Assist in evaluating if gas migration is a potential migration pathway
Fill data gaps	Indoor air	Three sample locations—one in each of the main buildings on the Larsen Marine property, and one outdoor ambient air sample (background)	VOC samples are collected with SUMMA canisters by opening the flow-controlled valve and slowly filling the canister using a flow controller to collect a time-integrated sample. Typically, samples are collected over an 8-hour period.	4	Above ground	4	TO-15 SIM VOCs	Assist in defining indoor air concentrations within Larsen Marine buildings

<sup>a</sup> Number of samples does not include quality control samples.

<sup>b</sup> An initial five locations were identified based on historical site groundwater data. Five additional locations may be sampled based on the results of the MIP investigation south of Plant 2.

**TABLE 2-5**  
Illinois Tier I Remediation Objectives for Chemicals Detected at the Site  
OMC Plant 2

Chemical Name	Groundwater <sup>a</sup> (mg/L)	Soil <sup>b</sup> (mg/kg)				
	Class I Aquifer	Industrial/Commercial Properties <sup>c</sup>		Residential <sup>d</sup> Properties	Soil Component of Groundwater Ingestion (Class I) <sup>e</sup>	Acceptable Detection Limit <sup>e</sup>
		Industrial/Commercial	Construction Worker			
Acenaphthene	0.42	120,000 <sup>f</sup>	120,000 <sup>f</sup>	4,700 <sup>f</sup>	570 <sup>f</sup>	*
Acetone	0.7	100,000 <sup>k</sup>	100,000 <sup>k</sup>	7,800 <sup>f</sup>	16 <sup>f</sup>	*
Anthracene	2.1	610,000 <sup>f</sup>	610,000 <sup>f</sup>	23,000 <sup>f</sup>	12,000 <sup>f</sup>	*
Benzene	0.005 <sup>g</sup>	1.6 <sup>h</sup>	2.2 <sup>h</sup>	0.8 <sup>h</sup>	0.03	*
Benzo(a)anthracene	0.00013 <sup>i</sup>	8 <sup>h</sup>	170 <sup>h</sup>	0.9 <sup>h</sup>	2	*
Benzo(b)fluoranthene	0.00018 <sup>i</sup>	8 <sup>h</sup>	170 <sup>h</sup>	0.9 <sup>h</sup>	5	*
Benzo(k)fluoranthene	0.00017 <sup>i</sup>	78 <sup>h</sup>	1,700 <sup>h</sup>	9 <sup>h</sup>	49	*
Benzo(a)pyrene	0.0002 <sup>g,i</sup>	0.8 <sup>h</sup>	17 <sup>h</sup>	0.09 <sup>h,j</sup>	8	*
Bis(2-chloroethyl)ether	0.01 <sup>i</sup>	0.47 <sup>h</sup>	0.66 <sup>h</sup>	0.2 <sup>h,j</sup>	0.0004 <sup>h,j</sup>	0.66
Bis(2-ethylhexyl)phthalate	0.006 <sup>g</sup>	410 <sup>h</sup>	4,100 <sup>f</sup>	48 <sup>h</sup>	3,600	*
Bromodichloromethane	0.0002 <sup>i</sup>	92 <sup>h</sup>	2,000 <sup>h</sup>	10 <sup>h</sup>	0.6	*
Bromoform	0.001 <sup>i</sup>	100 <sup>h</sup>	140 <sup>h</sup>	53 <sup>h</sup>	0.8	*
Carbon disulfide	0.7	720 <sup>k</sup>	9.0 <sup>f</sup>	720 <sup>k</sup>	32 <sup>f</sup>	*
Carbon tetrachloride	0.005 <sup>g</sup>	0.64 <sup>h</sup>	0.90 <sup>h</sup>	0.3 <sup>h</sup>	0.07	*
Chlorobenzene	0.1 <sup>g</sup>	210 <sup>f</sup>	1.3 <sup>f</sup>	130 <sup>f</sup>	1	*
Chloroform	0.0002 <sup>i</sup>	0.54 <sup>h</sup>	0.76 <sup>h</sup>	0.3 <sup>h</sup>	0.6	*
Chrysene	0.0015 <sup>i</sup>	780 <sup>h</sup>	17,000 <sup>h</sup>	88 <sup>h</sup>	160	*
Dibenzo(a,h)anthracene	0.0003 <sup>i</sup>	0.8 <sup>h</sup>	17 <sup>h</sup>	0.09 <sup>h,j</sup>	2	*
1,2-Dibromo-3-chloropropane	0.0002 <sup>g</sup>	4 <sup>h</sup>	0.11 <sup>f</sup>	0.46 <sup>g</sup>	0.002	*
Di-n-butyl phthalate	0.7	2,300 <sup>k</sup>	2,300 <sup>k</sup>	2,300 <sup>k</sup>	2,300 <sup>k</sup>	*
1,2-Dichlorobenzene	0.6 <sup>g</sup>	560 <sup>k</sup>	310 <sup>f</sup>	560 <sup>k</sup>	17	*
1,4-Dichlorobenzene	0.075 <sup>g</sup>	17,000 <sup>f</sup>	340 <sup>f</sup>	11,000 <sup>f</sup>	2	*
3,3'-Dichlorobenzidine	0.02 <sup>i</sup>	13 <sup>h</sup>	280 <sup>h</sup>	1 <sup>h</sup>	0.007 <sup>h,j</sup>	1.3
1,1-Dichloroethane	0.7	1,700 <sup>k</sup>	130 <sup>f</sup>	1,300 <sup>f</sup>	23 <sup>f</sup>	*
1,2-Dichloroethane	0.005 <sup>g</sup>	0.70 <sup>h</sup>	0.99 <sup>h</sup>	0.4 <sup>h</sup>	0.02	*
1,1-Dichloroethylene	0.007 <sup>g</sup>	1,500 <sup>k</sup>	300 <sup>m</sup>	700 <sup>f</sup>	0.06	*
cis-1,2-Dichloroethylene	0.07 <sup>g</sup>	1,200 <sup>k</sup>	1,200 <sup>k</sup>	780 <sup>f</sup>	0.4	*
trans-1,2-Dichloroethylene	0.1 <sup>g</sup>	3,100 <sup>k</sup>	3,100 <sup>k</sup>	1,600 <sup>f</sup>	0.7	*
1,2-Dichloropropane	0.005 <sup>g</sup>	23 <sup>f</sup>	0.50 <sup>f</sup>	9 <sup>h</sup>	0.03	*
1,3-Dichloropropene	0.001 <sup>i</sup>	2.1 <sup>h</sup>	0.39 <sup>f</sup>	1.1 <sup>h</sup>	0.004 <sup>h</sup>	0.005
Diethyl phthalate	5.6	2,000 <sup>k</sup>	2,000 <sup>k</sup>	2,000 <sup>k</sup>	470 <sup>f</sup>	*
2,4-Dimethylphenol	0.14	41,000 <sup>f</sup>	41,000 <sup>f</sup>	1,600 <sup>b</sup>	9 <sup>b</sup>	*
2,4-Dinitrotoluene	0.00002 <sup>i</sup>	8.4 <sup>h</sup>	180 <sup>h</sup>	0.9 <sup>h</sup>	0.0008 <sup>a,i</sup>	0.250
2,6-Dinitrotoluene	0.00031 <sup>i</sup>	8.4 <sup>h</sup>	180 <sup>h</sup>	0.9 <sup>g</sup>	0.0007 <sup>a,i</sup>	0.260
Di-n-octyl phthalate	0.14	10,000 <sup>k</sup>	4,100 <sup>f</sup>	1,600 <sup>f</sup>	10,000 <sup>k</sup>	*

TABLE 2-5

Illinois Tier I Remediation Objectives for Chemicals Detected at the Site  
OMC Plant 2

Chemical Name	Groundwater <sup>a</sup> (mg/L)	Soil <sup>b</sup> (mg/kg)				
	Class I Aquifer	Industrial/Commercial Properties <sup>c</sup>		Residential <sup>d</sup> Properties	Soil Component of Groundwater Ingestion (Class I) <sup>e</sup>	Acceptable Detection Limit <sup>a</sup>
		Industrial/Commercial	Construction Worker			
Ethylbenzene	0.7 <sup>g</sup>	400 <sup>k</sup>	58 <sup>i</sup>	400 <sup>k</sup>	13	*
Fluoranthene	0.28	82,000 <sup>f</sup>	82,000 <sup>f</sup>	3,100 <sup>f</sup>	4,300 <sup>f</sup>	*
Fluorene	0.28	82,000 <sup>f</sup>	82,000 <sup>f</sup>	3,100 <sup>f</sup>	560 <sup>f</sup>	*
Hexachlorobenzene	0.00006 <sup>i</sup>	1.8 <sup>h</sup>	2.6 <sup>h</sup>	0.4 <sup>h</sup>	2	*
Hexachlorocyclopentadiene	0.05 <sup>g</sup>	16 <sup>f</sup>	1.1 <sup>f</sup>	10 <sup>f</sup>	400	*
Hexachloroethane	0.007	2,000 <sup>f</sup>	2,000 <sup>f</sup>	78 <sup>f</sup>	0.5 <sup>f</sup>	*
Indeno(1,2,3-c,d)pyrene	0.00043 <sup>f</sup>	8 <sup>h</sup>	170 <sup>h</sup>	0.9 <sup>h</sup>	14	*
Isophorone	1.4	4,600 <sup>k</sup>	4,600 <sup>k</sup>	4,600 <sup>k</sup>	8 <sup>f</sup>	*
Methylene chloride (Dichloroethane)	0.005 <sup>g</sup>	24 <sup>h</sup>	34 <sup>h</sup>	13 <sup>h</sup>	0.02 <sup>h</sup>	*
Naphthalene	0.14	270 <sup>f</sup>	1.8 <sup>f</sup>	170 <sup>f</sup>	12 <sup>f</sup>	*
Nitrobenzene	0.0035	140 <sup>h</sup>	9.4 <sup>f</sup>	39 <sup>f</sup>	0.1 <sup>f,i</sup>	0.26
N-nitrosodiphenylamine	0.0032 <sup>f</sup>	1,200 <sup>h</sup>	25,000 <sup>h</sup>	130 <sup>h</sup>	1 <sup>h</sup>	*
N-Nitrosodi-n-propylamine	0.0018 <sup>f</sup>	0.8 <sup>h</sup>	18 <sup>h</sup>	0.09 <sup>h,i</sup>	0.00005 <sup>h,i</sup>	0.0018
Phenol	0.1 <sup>g</sup>	1,000,000 <sup>f</sup>	120,000 <sup>f</sup>	47,000 <sup>f</sup>	100 <sup>f</sup>	*
Polychlorinated biphenyls (PCBs)	0.0005 <sup>g</sup>	1 <sup>i</sup>	1 <sup>i</sup>	1 <sup>i</sup>	1	*
Pyrene	0.21	61,000 <sup>f</sup>	61,000 <sup>f</sup>	2,300 <sup>f</sup>	4,200 <sup>f</sup>	*
Styrene	0.1 <sup>g</sup>	1,500 <sup>k</sup>	430 <sup>f</sup>	1,500 <sup>k</sup>	4	*
Tetrachloroethylene (PCE)	0.005 <sup>g</sup>	20 <sup>h</sup>	28 <sup>h</sup>	11 <sup>h</sup>	0.06	*
Toluene	1.0 <sup>g</sup>	650 <sup>k</sup>	42 <sup>k</sup>	650 <sup>k</sup>	12	*
1,2,4-Trichlorobenzene	0.07 <sup>g</sup>	3,200 <sup>k</sup>	920 <sup>f</sup>	780 <sup>f</sup>	5	*
1,1,1-Trichloroethane	0.2 <sup>g</sup>	1,200 <sup>k</sup>	1,200 <sup>k</sup>	1,200 <sup>k</sup>	2	*
1,1,2-Trichloroethane	0.005 <sup>g</sup>	1,800 <sup>k</sup>	1,800 <sup>k</sup>	310 <sup>h</sup>	0.02	*
Trichloroethylene (TCE)	0.005 <sup>g</sup>	8.9 <sup>h</sup>	12 <sup>h</sup>	5 <sup>h</sup>	0.06	*
Vinyl Acetate	7	1,600 <sup>f</sup>	10 <sup>f</sup>	1,000 <sup>f</sup>	170 <sup>f</sup>	*
Vinyl Chloride	0.002 <sup>g</sup>	1.1 <sup>h</sup>	1.1 <sup>f</sup>	0.28 <sup>h</sup>	0.01 <sup>i</sup>	*
m-Xylene (1,3-dimethylbenzene)		420 <sup>k</sup>	420 <sup>k</sup>	420 <sup>k</sup>	210	*
o-Xylene (1,2-dimethylbenzene)		410 <sup>k</sup>	410 <sup>k</sup>	410 <sup>k</sup>	190	*
p-Xylene (1,4-dimethylbenzene)		460 <sup>k</sup>	460 <sup>k</sup>	460 <sup>k</sup>	200	*
Xylenes, total	10.0 <sup>g</sup>	320 <sup>k</sup>	320 <sup>k</sup>	320 <sup>k</sup>	150	*
<b>Ionizable Organics</b>						
2-Chlorophenol	0.035	10,000 <sup>f</sup>	10,000 <sup>f</sup>	390 <sup>f</sup>	4 <sup>f,n</sup>	*
2,4-Dichlorophenol	0.021	6,100 <sup>f</sup>	6,100 <sup>f</sup>	230 <sup>f</sup>	1 <sup>f,n</sup>	*
2,4-Dinitrophenol	0.014	4,100 <sup>f</sup>	410 <sup>f</sup>	160 <sup>f</sup>	0.2 <sup>f,i</sup>	3.3
Pentachlorophenol	0.001 <sup>g</sup>	24 <sup>h,o</sup>	520 <sup>h,o</sup>	3 <sup>h,o</sup>	0.03 <sup>f,i</sup>	*



TABLE 2-5

Illinois Tier I Remediation Objectives for Chemicals Detected at the Site  
OMC Plant 2

Chemical Name	Groundwater <sup>a</sup> (mg/L)	Soil <sup>b</sup> (mg/kg)				
	Class I Aquifer	Industrial/Commercial Properties <sup>c</sup>		Residential <sup>d</sup> Properties	Soil Component of Groundwater Ingestion (Class I) <sup>e</sup>	Acceptable Detection Limit <sup>f</sup>
		Industrial/Commercial	Construction Worker			
2,4,6-Trichlorophenol	0.01 <sup>l</sup>	390 <sup>h</sup>	540 <sup>h</sup>	58 <sup>h</sup>	0.2 <sup>h,j,n</sup>	0.66
<b>Inorganics</b>						
Arsenic	0.05 <sup>g</sup>	1,200 <sup>g</sup>	61 <sup>b</sup>	750 <sup>g</sup>	0.05 <sup>m</sup>	*
Barium	2.0 <sup>g</sup>	140,000 <sup>b</sup>	14,000 <sup>b</sup>	5,500 <sup>b</sup>	2.0 <sup>m</sup>	*
Cadmium	0.005 <sup>g</sup>	2,000 <sup>b,r</sup>	200 <sup>b,r</sup>	78 <sup>b,r</sup>	0.005 <sup>m</sup>	*
Chloride	200 <sup>g</sup>	<sup>c</sup>	<sup>c</sup>	<sup>c</sup>	200 <sup>m</sup>	*
Chromium, total	0.1 <sup>g</sup>	420 <sup>g</sup>	690 <sup>b</sup>	230 <sup>b</sup>	0.1 <sup>m</sup>	*
Chromium, ion, trivalent		1,000,000 <sup>b</sup>	310,000 <sup>b</sup>	120,000 <sup>b</sup>	<sup>g</sup>	*
Chromium, ion, hexavalent		420 <sup>g</sup>	690 <sup>b</sup>	230 <sup>b</sup>		*
Cyanide, amenable	0.2 <sup>g,p</sup>	41,000 <sup>b</sup>	4,100 <sup>b</sup>	1,600 <sup>b</sup>	0.2 <sup>q,m</sup>	*
Iron	5.0 <sup>g</sup>	<sup>c</sup>	<sup>c</sup>	<sup>c</sup>	5.0 <sup>m</sup>	*
Lead	0.0075 <sup>g</sup>	400 <sup>k</sup>	400 <sup>k</sup>	400 <sup>k</sup>	0.0075 <sup>m</sup>	*
Mercury	0.002 <sup>g</sup>	610 <sup>b</sup>	61 <sup>b</sup>	10 <sup>b</sup>	0.002 <sup>m</sup>	*
Selenium	0.05 <sup>g</sup>	10,000 <sup>b</sup>	1,000 <sup>b</sup>	390 <sup>b</sup>	0.05 <sup>m</sup>	*
Silver	0.05 <sup>g</sup>	10,000 <sup>b</sup>	1,000 <sup>b</sup>	390 <sup>b</sup>	0.05 <sup>m</sup>	*
Sulfate	400 <sup>g</sup>	<sup>c</sup>	<sup>c</sup>	<sup>c</sup>	400 <sup>m</sup>	*

## Notes:

<sup>a</sup> From Illinois Section 742, Appendix B, Table E: Tier 1 Groundwater Remediation Objectives for the Groundwater Component of the Groundwater Ingestion Route.

<sup>b</sup> Soil remediation objectives based on human health criteria only.

<sup>c</sup> From Illinois Section 742, Appendix B, Table B: Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties.

<sup>d</sup> From Illinois Section 742, Appendix B, Table A: Tier 1 Soil Remediation Objectives for Residential Properties.

<sup>e</sup> From Illinois Section 742, Appendix B, Table B: Tier 1 Soil Remediation Objectives for Industrial/Commercial Properties.

<sup>f</sup> Calculated values corresponds to a target hazard quotient of 1.

<sup>g</sup> Value listed is also the Groundwater Quality Standard for this chemical pursuant to 35 IAC 620.410 for Class I Groundwater.

<sup>h</sup> Calculated value correspond to a cancer risk of 1 in 1,000,000.

<sup>i</sup> The groundwater remediation objective is equal to the ADL for carcinogens according to the procedures specified in 35 IAC 620.

<sup>j</sup> Level is at or below Contract Laboratory Program required quantitation limit for Regular Analytical Services (RAS).

<sup>k</sup> Soil saturation concentrations have been reached and alternative modeling approaches are required.

<sup>l</sup> 40 CFR 761 contains applicability requirements and methodologies for the development of PCB remediation objectives.

<sup>m</sup> Calculated values correspond to soil concentrations that should not result in air concentrations that exceed criteria for workplace air.

<sup>n</sup> Soil remediation objective for pH of 6.8.

<sup>o</sup> Ingestion soil remediation objective adjusted by a factor of 0.5 to account for dermal route.

<sup>p</sup> Remediation objective for groundwater is for total cyanide.

<sup>q</sup> The TCLP extraction must be done using water at a pH of 7.0.

<sup>r</sup> Value based on dietary Reference Dose.

\* = Indicates that the ADL is less than or equal to the specified remediation objective

TABLE 2-6

Summary of Existing Monitoring Well Sampling Locations  
OMC Plant 2

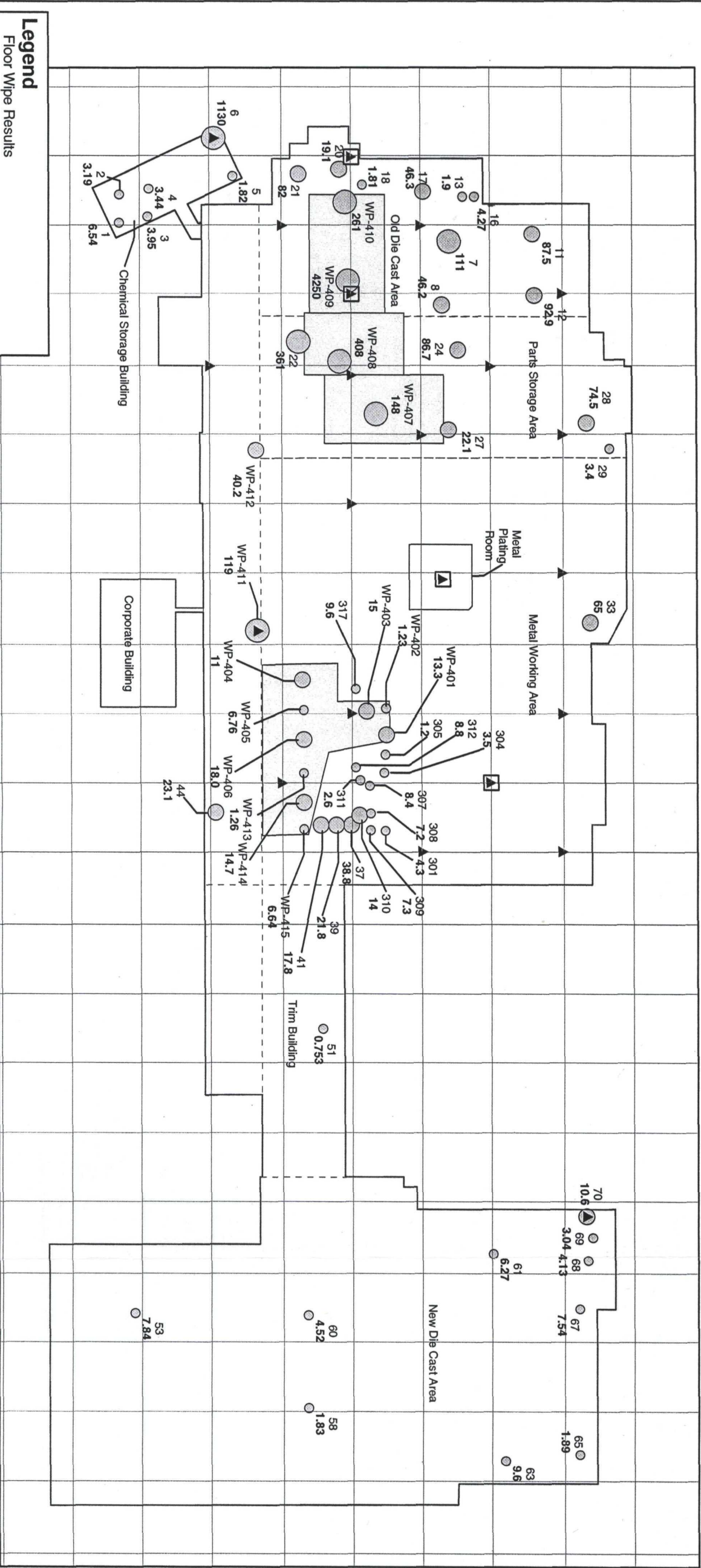
Well ID	Ground Elevation (ft)	Top Of Casing Elevation (ft)	Depth of Well (ft)	Construction Date	Well Diameter	Screened Interval (ft)
<b>Shallow</b>						
W-2A	583.1	584.98	574.5	07/19/1979	1.25" S.S.	580 - 575
W-3	589.8	586.71	577.9	07/23/1979	1.25" S.S.	583.2 - 578.2
W-4A	584	585.93	575.4	07/23/1979	2" S.S.	581 - 576
W-12	583	585.27	576	05/20/1980	2" S.S.	581 - 576
W-13	584.87	587.06	574.7	05/21/1980	2" S.S.	580 - 575
MW-14	--	--	--	--	--	--
MW-15	--	--	--	--	--	--
<b>Intermediate</b>						
W-2B	583.2	585.83	563.3	07/20/1979	1.25" S.S.	566 - 564
W-4B	583.9	586.8	564.3	07/24/1979	2" S.S.	567 - 565
W-6 (587.69 TOC)	--	587.69	--			
W-9-Intermediate	585.5	587.7	560	09/23/1991	2" S.S.	575 - 560
W-10-Intermediate	584.7	587.6	562.2	09/24/1991	2" S.S.	578 - 563
W-12-Intermediate	584.3	587.1	556.3	09/24/1991	2" S.S.	571 - 556
<b>Deep</b>						
W-4	--	582.83	--	--	--	--
W-4C-Deep	583.9	587.23	557.3	07/24/1979	2" S.S.	560 - 558
W-5-Deep	586.5	588.89		09/30/1992	2" S.S.	563 - 558
W-7-Deep	584.6	586.6	557.3	05/11/1993	2" S.S.	562 - 557
W-11	588.2	589.26	562.7	07/24/1992	2" S.S.	567.7 - 562.7
MW-T101	--	--	--	--	--	--
MW-T104	--	--	--	--	--	--
MW-T105 (AKA TP-8)	--	--	--	--	--	--
MW-T106 (AKA TP-7)	--	--	--	--	--	--
MW-T107 (AKA TP-9)	--	--	--	--	--	--

## Notes:

-- = Not Available

S.S. = Stainless steel

AKA = "Also known as"



**Legend**

Floor Wipe Results

- < 10
- 11-100
- > 100

▲ Core Sample Location

▣ Core Sample Location and SPLP Analysis

▣ Area Decontaminated During USEPA Removal Activities

All concentrations in ug/100 cm<sup>2</sup>  
Source: Tetra Tech 2002 and 2003

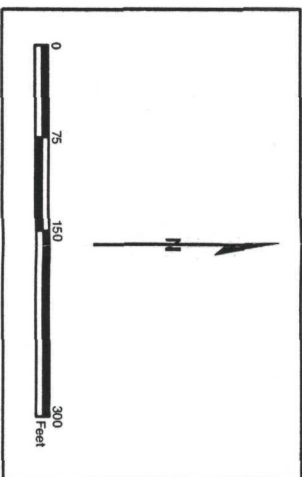
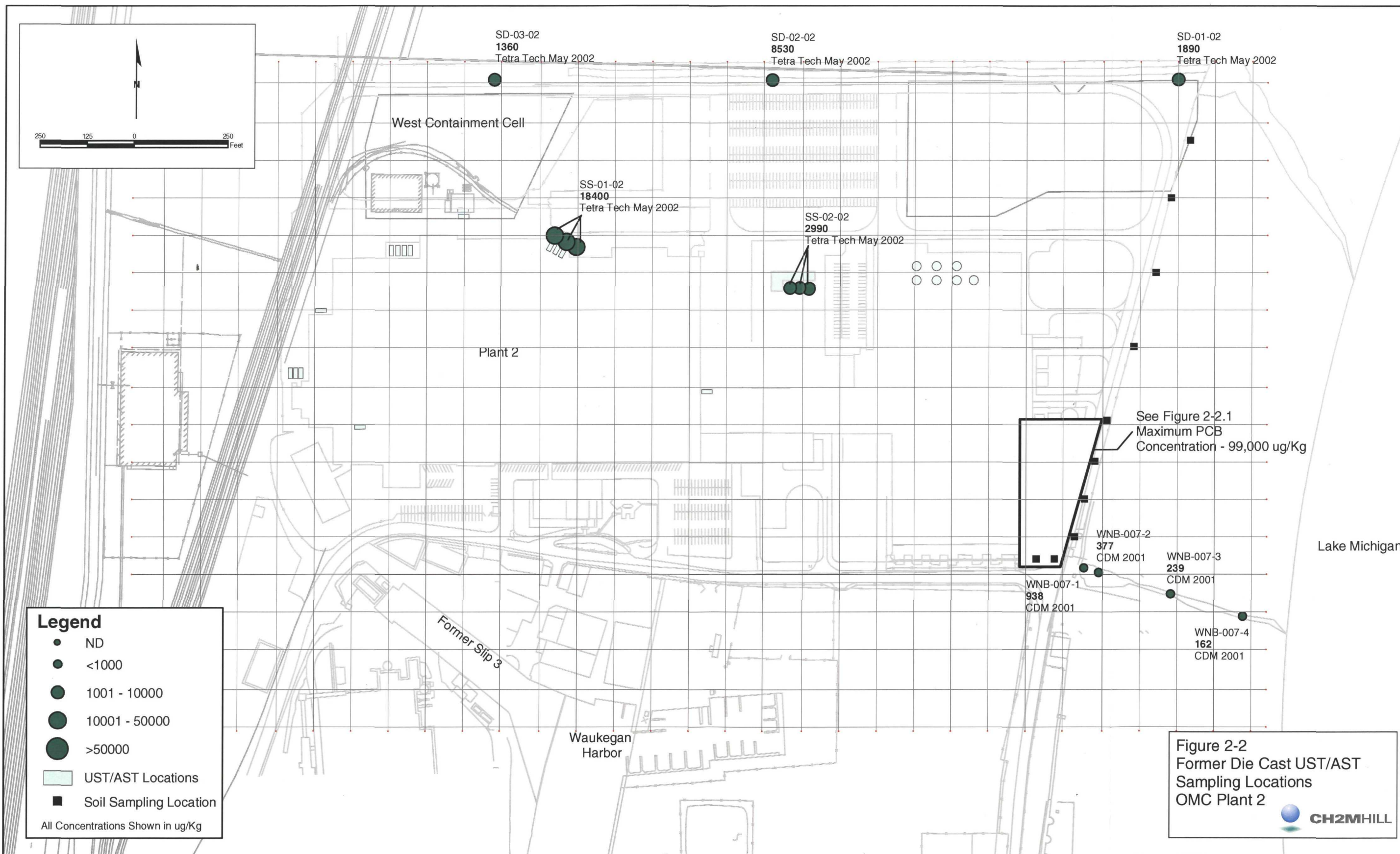


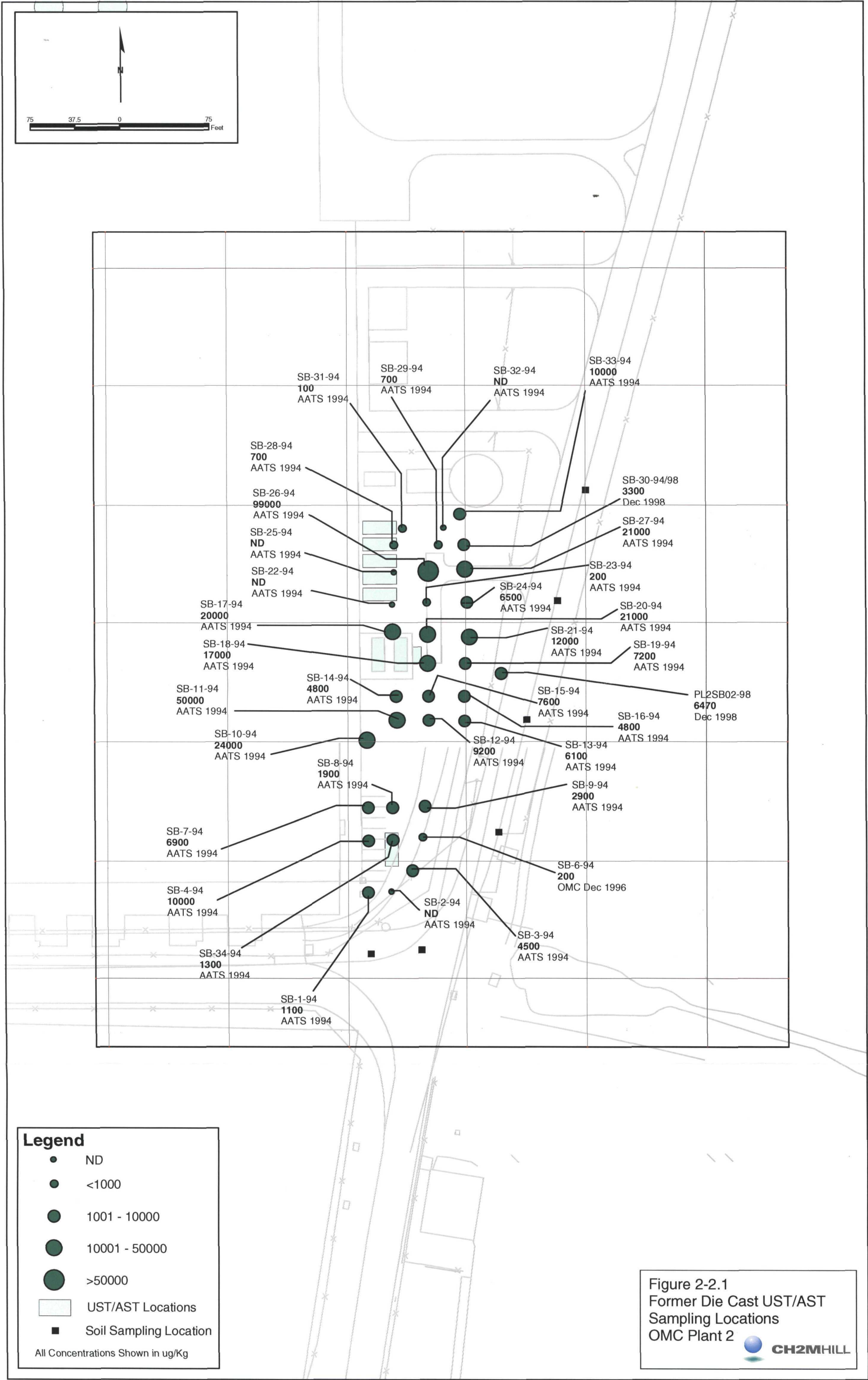
Figure 2-1  
Concrete Floor Core Sample Locations  
OMC Plant 2

**CH2MHILL**











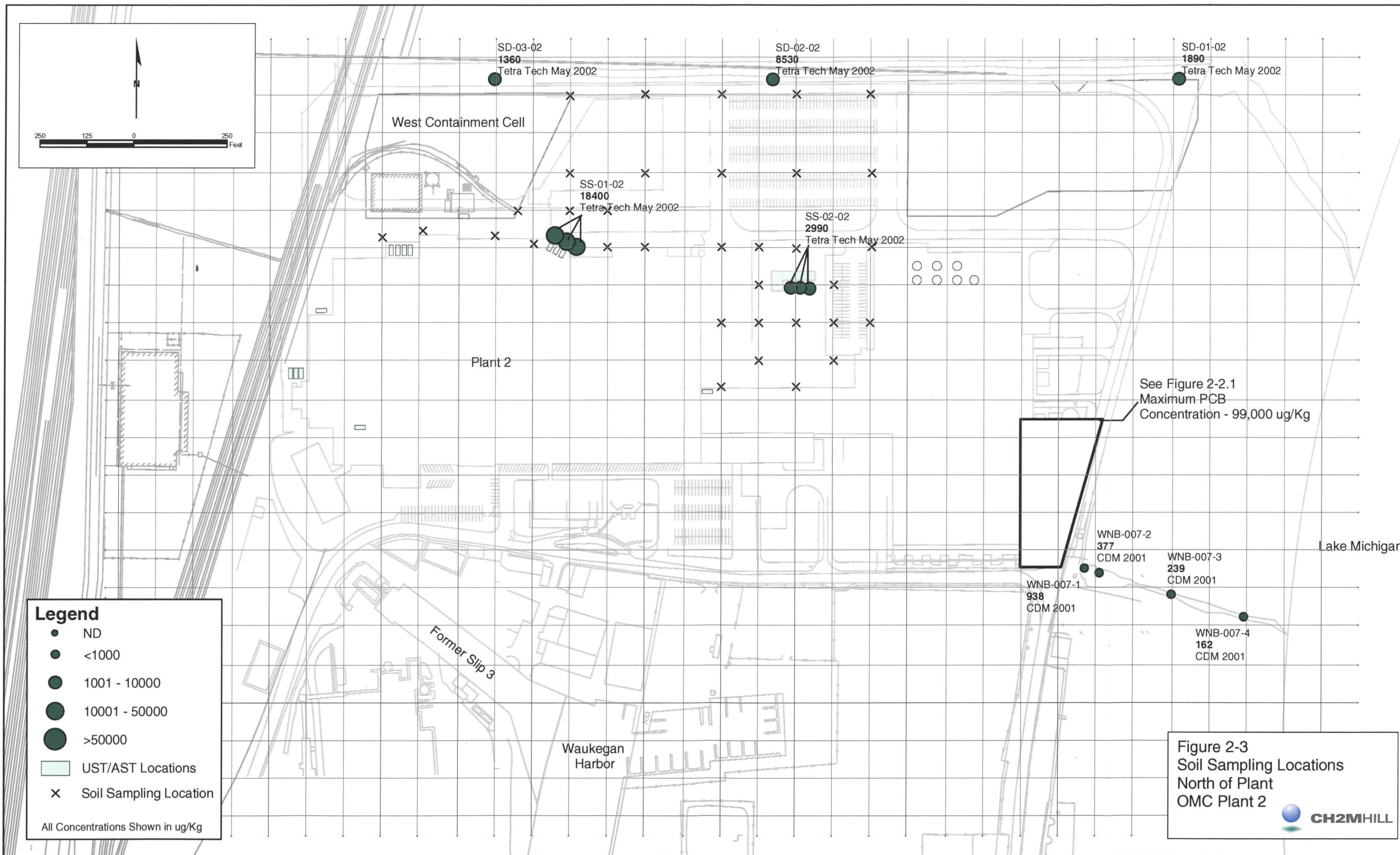
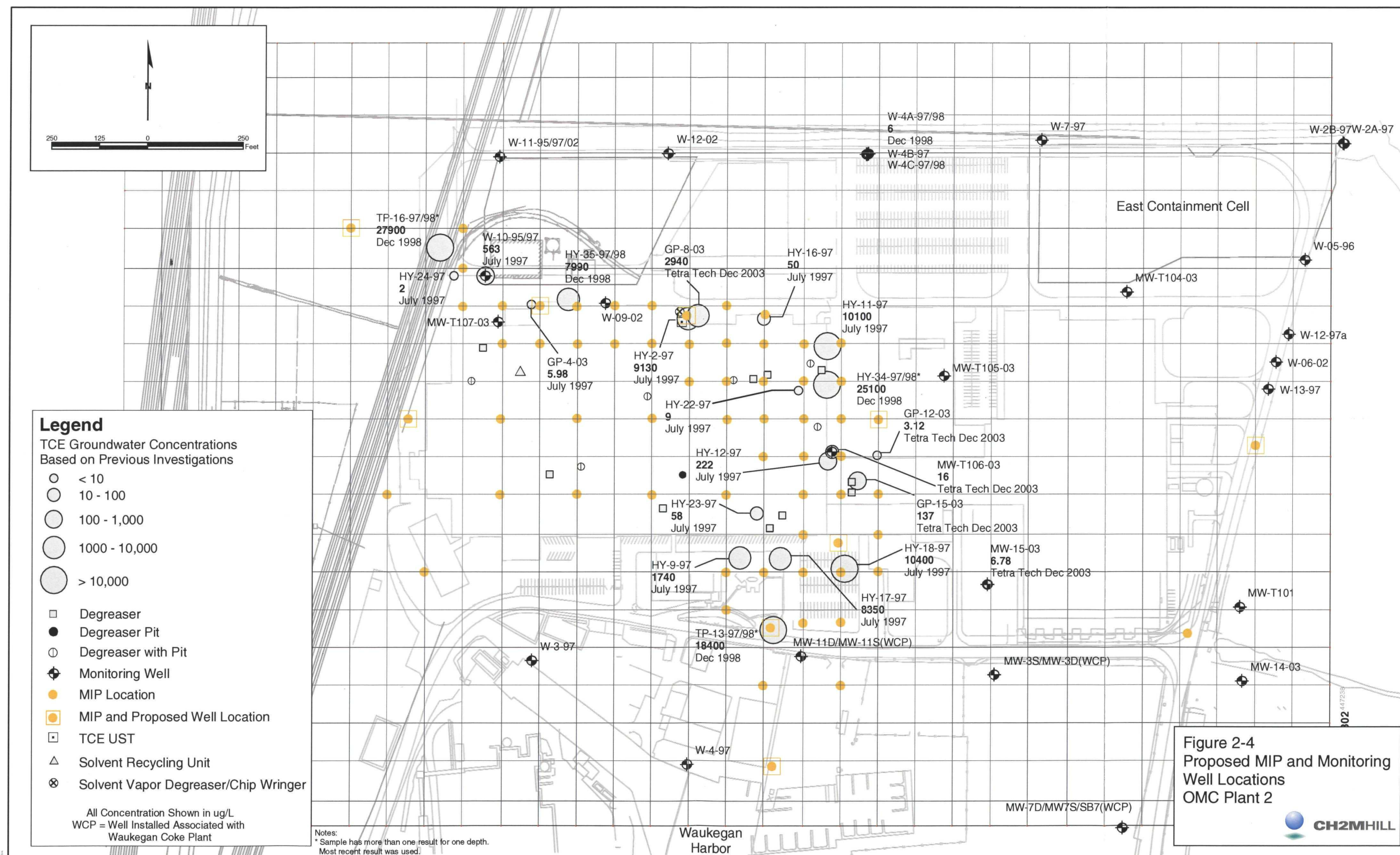


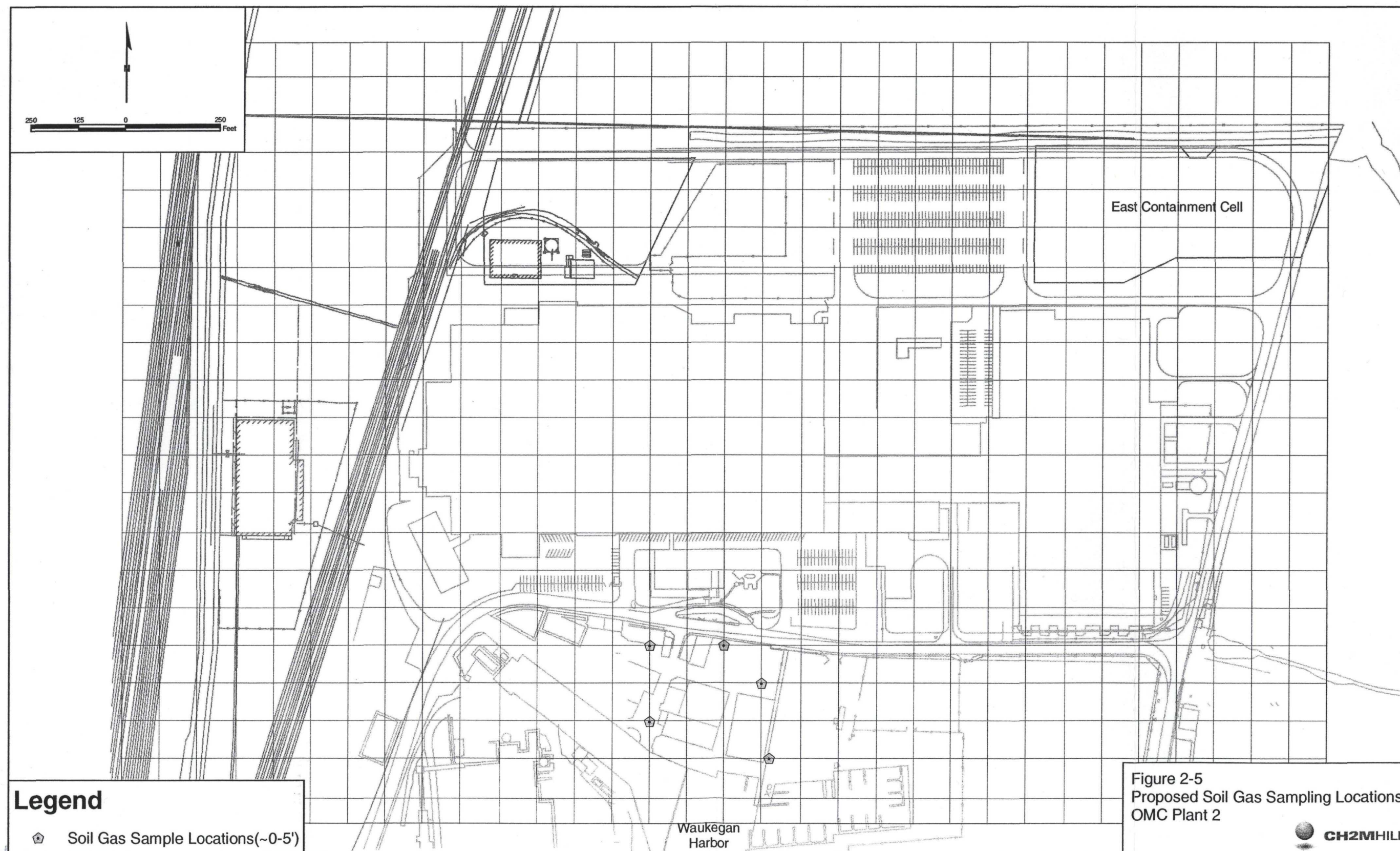
Figure 2-3  
Soil Sampling Locations  
North of Plant  
OMC Plant 2











# Legend

 Soil Gas Sample Locations(~0-5')

Figure 2-5  
Proposed Soil Gas Sampling Locations  
OMC Plant 2



## SECTION 3

# Field Investigation Program

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The specific investigation objectives were developed based on observations during the site visits, current site conditions, available information on past activities and suspected source areas, and available soil and groundwater analytical data.

## 3.1 Objectives

The general objectives for the field investigation are to:

- Perform site reconnaissance activities including a condition assessment of previously installed monitoring wells and collection of groundwater level measurements and well depths from existing monitoring wells.
- Sample building materials (metal structures, piping, concrete walls, and floors) to evaluate handling and disposal options.
- Perform testing of sanitary and storm sewer lines to determine effectiveness of previous sewer plugging and capping actions.
- Perform a field survey measuring width and thickness of sediments along multiple transects to determine the volume of sediment in the North Ditch that will require remediation.
- Define the nature and extent of the contamination in surface and subsurface soil and groundwater, including investigation and delineation of areas of suspected or existing NAPL, to support the assessment of potential risk to human health and the environment and to assist in evaluation of potential remedial alternatives.
- Collect data on soil properties that will be used to evaluate contaminant fate and transport and remedial alternatives.

## 3.2 Tasks

The following tasks will be performed to complete the field investigation objectives:

**Site Reconnaissance** – Information on the building access, building layout, structural materials, well inventory, property boundaries and utility right-of-ways, and historical land use will be used to refine and verify some assumptions made during scoping of the field investigation.

**Mobilization** – This task consists of constructing support facilities, mobilizing the equipment to the site prior to the field activities, and establishing the field office.

**Building Investigation** – Wipe and concrete core samples will be collected from the Plant 2 building materials to determine if residual contamination exists that may impact future



actions considered for the building and handling and disposal options for building materials. This task will also include testing sanitary and storm sewers to verify that they are no longer connected to the Waukegan Harbor.

**Soil and Groundwater Investigations**—Sample data generated during these tasks will help define the current nature and extent of soil and groundwater contamination. Lithologic and geotechnical information will be used to evaluate contaminant fate and transport, potential site risk and remedial alternatives.

**Soil Gas and Indoor Air Investigations**—Data generated during these activities will be used to determine if volatilization from the chlorinated solvent plume may potentially cause inhalation risks.

**Surveying**—Task will establish 100-foot sampling grid on property, confirm location and elevation of existing monitoring wells, and tie in new monitoring wells to existing coordinate system.

**Dispose of Investigation Derived Waste**—Task includes characterizing and disposing of investigation derived wastes (IDW) in accordance with local, State, and Federal regulations.

**Demobilization**—At the completion of fieldwork, personnel, equipment, and supplies will be demobilized from the site.

### **3.3 Field Operations and Procedures**

This section provides an overview of the equipment, operations, and procedures that will be performed during the RI. It also references specific FOPs in Appendix B which provide step-by-step procedures for conducting the field task. In the instances where FOPs are not referenced, the text of that section will act as the FOP.

#### **3.3.1 Site Reconnaissance**

The following site reconnaissance tasks will be completed prior to the start of sampling activities:

- Confirming health and safety information including the route and travel time to the hospital specified in the Health and Safety Plan (HASP) and addresses of local fire and police departments.
- Meeting with City of Waukegan staff to coordinate site access including copies of site gate and facility keys.
- Locating the Federal Express office nearest the site and note its hours of operation. Determine whether the office will provide sample pick-up service.
- Mapping the locations and conditions (metal, concrete, painted and unpainted concrete block, presence of oily film, flaking paint, etc.) of interior building walls and overhead piping runs to refine the number of PCB wipe and core samples required from building materials. A photographic record of the building interior will also be created.
- Identify the storm and sanitary sewers that will be tested.

- Locating and inspecting existing onsite and offsite monitoring wells. A hand-held Global Positioning System (GPS) unit will be used to determine the coordinates to verify identification of the monitoring wells. The well inspections will include visual observations of well condition, well construction (e.g., depth of well, casing material), and groundwater level measurements. All observations and measurements will be documented in the field notebook.
- Preliminary sampling locations will be inspected to determine if modifications are necessary based on structural limitations (low-overhead clearances or building support columns) or other potential hazards (underground utilities, etc). Any modifications necessary will be recorded along with the reason for the modification.
- The site surveyor will lay out a 100-foot grid outside of Plant 2 and within the building for use in identifying locations of samples and identifying material characteristics during the reconnaissance survey.

The level of health and safety protection during the site-reconnaissance activities will be Level D.

### **3.3.2 Mobilization**

Prior to initiating any field work the following preparatory activities must be completed:

- Mobilize and set up support facilities (phone, electricity, water, sewer, security [if necessary])
- Mobilize all field office equipment and supplies (fax and copy machines, computer, water cooler)
- Identify and set up the temporary IDW storage area
- Identify and contact all utility companies to get underground utility clearance for all sampling locations. Locate internal or private utilities and underground obstructions (tunnels, pipe chases, etc.).
- Post signs that provide appropriate contacts for information and for reporting suspected criminal activities
- Obtain and transport the identified field supplies (e.g., PPE, sample containers, preservatives, sample forms and other related items) and field monitoring equipment to the site
- Mobilize direct push (e.g., Geoprobe®) and drilling contractor and supplies and materials
- Confirm that analyses are scheduled through the USEPA CLP and the independent laboratories
- Confirm that field equipment is in proper working order and it has received the appropriate quality control checks

- Collect a sample of the water that will be used for decontamination purposes and have it analyzed

During mobilization activities, the Field Team Leader (FTL) will perform walk-through inspection of the site and inspect and generate field sampling maps. The level of health and safety protection to be used during the mobilization activities will be Level D.

### 3.3.3 Building Investigation

#### 3.3.3.1 Material Sampling

The sampling and analysis of building materials (piping, walls, floors, etc.) will be conducted to evaluate material handling and disposal options. The type and number of samples to be collected will vary based on the material being sampled. Sample collection methodology is presented below by building material.

**Metal Structures and Piping.** Unpainted metal structures and piping are non-porous surfaces for sampling, material handling, and waste disposal purposes. Metal structures and piping may be sold for scrap metal if wipe sample results indicate concentrations are less than  $10\ \mu\text{g}/100\ \text{cm}^2$ . If wipe sample concentrations are above  $10\ \mu\text{g}/100\ \text{cm}^2$ , decontamination or thermal treatment may be required.

Wipe samples will be collected from a representative proportion of metal and piping surfaces. The procedures to be used for the collection of wipe samples are presented in *FOP-01 PCB Wipe Sample Collection*.

**Porous Surfaces Other than Floors.** Wipe samples will be collected for PCB analysis on porous wall surfaces (including painted metal walls). Wipe samples will be collected from 50 random locations within the Old Die Cast, Parts Storage, and Metal Working Areas.

Bulk samples (e.g., concrete cores) will be collected from selected visibly contaminated concrete walls or exceed the wipe sample criterion on  $10\ \mu\text{g}/100\ \text{cm}^2$ . Bulk concrete sample collection procedures are detailed in *FOP-02 Bulk Concrete Sample Collection*.

**Porous Surfaces—Floors.** Core samples will be collected from select concrete floor locations. Multiple depth intervals will be analyzed at each core location to determine the depth of PCB penetration into the concrete. Cores will be analyzed for PCBs and selected core samples will also be analyzed for total metals and cyanide. In addition, selected samples will be analyzed using the SPLP to evaluate the leaching potential of PCBs from concrete in the event that the concrete is left in place. In former metal plating areas, concrete core samples from the floor will also be analyzed using the SPLP for total metals and cyanide.

Bulk concrete floor sampling procedures are presented in *FOP-02 Bulk Concrete Sample Collection*.

#### 3.3.3.2 Sanitary and Storm Sewers

Sanitary and storm sewer lines outside of the main building will be tested to verify their location and that they are no longer connected to Waukegan Harbor. Selected sanitary sewer lines beneath the western portion of Plant 2 (e.g., the Metal Working Area) will also be tested. Historical sewer maps will be reviewed prior to the start up of field activities such that the locations of sanitary and storm sewers for testing can be verified during the site reconnaissance task.

Characterizing storm and sanitary sewer flow direction and outfall location may include one or more than one of the following:

- Lamping of short storm and sanitary sewer lines to determine flow direction, pipe condition, and if there are any sediments in the pipes. Lamping involves shining a high intensity lamp from an access point such as a manhole or catch basin down the pipeline to another point where the sewer connection can be accessed.
- Dye testing consists of introducing a quantity of water treated with highly visible and environmentally safe dye into the upstream end of a sewer line at a catch basin or manhole. Downstream outfalls or receiving water bodies are then observed for flow of the dye. This technique can be used to determine the storm and sanitary sewer connection from the OMC Plant 2 property to the water bodies.
- Smoke testing may be conducted to confirm the connection of OMC Plant 2 storm and sanitary sewers to the sewer system down stream. Smoke testing consists of introducing an innocuous concentrated smoke into the storm and sanitary sewer system with blowers to spread the smoke throughout the system. Any open connection to the system will become visibly evident, as smoke will escape at that location.
- If the methods presented above are unsuccessful at defining the storm and sanitary sewer flow, the lines in question can be televised. Televising a sewer line involves putting a camera down the sewer line and televising the sewer pipe condition. Televising the lines would locate connecting sewers, defining pipe condition, and could locate areas of sediment deposits in the pipeline. Televising storm and sanitary sewers would only be completed if the other methods outlined above were unsuccessful.
- The storm and sanitary sewer locations, depth of manholes, catch basins, flow lines of pipes, etc., will be surveyed and tied into the city of Waukegan and OMC Plant 2 site maps so that storm and sanitary sewer flow direction, pipe size, pipe slope, and potential sewer sampling locations can be portrayed.

Previously unknown storm and sanitary sewer runs that are discovered will be characterized as follows:

- When located, any manholes, catch basins, outfalls, etc., will be marked by painting or flagging a lath and placing it adjacent to the storm and sanitary sewer feature for future survey purposes. Each new storm and sanitary sewer line or feature will be surveyed so that it can be included on one of the site maps.
- If possible or practicable, the depth of the manholes will be measured
- The size, type, and condition of the storm and sanitary sewer pipe will also be noted

### **3.3.4 Soil and Sediment Investigations**

The soil and sediment investigation will be conducted to collect data that will be used to:

- Determine the volume of sediment in the North Ditch that will require remediation
- Define the nature and extent of soil contamination (CPAH and PCBs) in the Former Die Cast UST area located east of OMC Plant 2



- Collect soil samples from the vicinity of the PCB AST area and parking lot areas north of the OMC Plant 2 building to evaluate direct-contact risk
- Collect soil samples from the vicinity of the grassy area around the south side of the building to confirm soils in the area do not pose a direct-contact risk
- Define nature and extent of soils potentially contaminated with NAPL beneath the OMC Plant 2 building
- Determine contaminant concentrations in soil beneath the building at select groundwater investigation locations
- Characterize the lithologic and geotechnical properties of site-specific soils (e.g., grain size, bulk density, porosity, moisture content, total organic carbon, soil oxidant demand, etc.) that will be used in the evaluation of contaminant fate and transport, the analysis of risk, and the remedial alternative evaluation

#### **3.3.4.1 North Ditch Sediment Volume Estimate**

A field survey will be performed to estimate the volume of sediment in the North Ditch (measuring width and thickness of sediments along multiple transects). Sediment thickness locations will be staked and survey coordinates determined during site reconnaissance activities. The sediments on the North Ditch will be poled on a grid pattern and transects with a range pole equipped a metal tip and steel shaft to determine the thickness of soft sediment. The sediment probing will be accomplished with waders and appropriate PPE. Sediment thickness transects will be spaced approximately every 300 feet. Each transect will include three thickness measurements, one near each shore sediment/water interface and one at the approximate center of each transect.

#### **3.3.4.2 Soil MIPs Investigation**

The soil investigation will be conducted in conjunction with the groundwater investigation using direct push technology. The investigation will be conducted using MIPs technology to determine vertical delineation of contamination in soil and groundwater. The procedures and equipment applicable to the MIPs investigation are included in *FOP-04 Membrane Interface Probe Sample Collection*.

MIPs will be performed at approximately 65 locations beneath the existing building (Figure 2-4) with up to 25 additional locations may be investigated to refine the delineation of identified contamination areas. Selected soil samples from the unsaturated zone (approximately 10 percent) will be sent to a CLP laboratory for correlating the MIPs results to soil concentrations.

#### **3.3.4.3 Soil Sample Collection from Locations Beneath the Building**

Soil samples from locations beneath the building will be collected from the 0-4-foot interval and will be analyzed for VOCs. Selected samples will be analyzed for lithologic and geotechnical parameters. Samples will be collected on a grid with 200-foot spacing. In suspected source areas the grid spacing will be reduced to 100-foot spacing. Soil samples will be collected using direct push (e.g., Geoprobe®) methods, or equivalent methods (e.g., split-spoon sampler). Procedures and equipment for soil sample collection are presented in:

- *FOP-03 Direct Push Soil Sample Collection*
- *FOP-05 Hollow-Stem Auger Drilling and Soil Sample Collection*

- *FOP-06 Monitoring Well and Soil Boring Abandonment*
- *FOP-07 Volatile Organic Compound Soil Sampling*
- *FOP-08 Soil Oxidant Demand Sample Collection*
- *FOP-17 Decontamination of Drilling Rigs and Equipment*

#### **3.3.4.4 Soil Sample Collection from Locations Outside Building**

Soil sample locations not beneath the building will be collected from 0 feet to 2 feet bgs and 2 feet bgs to 4 feet bgs. Soil samples will be analyzed for VOCs, SVOCs, and PCBs. Soil samples will be collected on a grid with 200-foot spacing. In suspected source areas grid spacing will be reduced to 100 feet. Saturated soil samples will also be collected during the installation of new monitoring well. The saturated soil samples will be analyzed for geotechnical properties.

Soil samples will be collected using direct push (e.g., Geoprobe®) methods, a hand auger, or equivalent methods (e.g., split-spoon sampler). Procedures and equipment for soil sample collection are presented in:

- *FOP-03 Direct Push Soil Sample Collection*
- *FOP-05 Hollow-Stem Auger Drilling and Soil Sample Collection*

#### **3.3.4.5 Screening for the Presence of DNAPLs**

High concentrations of TCE or other organic compounds may be present in subsurface soils as DNAPL. The MIP system will be used to provide data on the nature and extent of DNAPL in soils. MIP procedures are presented in *FOP-04 Membrane Interface Probe Sample Collection*. Soil samples will be collected using direct push or similar methods from areas suspected to contain DNAPL and evaluated to determine whether DNAPL is present (oily-sheen, free-product, Sudan, etc).

### **3.3.5 Groundwater Investigation**

The objectives of the groundwater investigation are to:

- Establish the site-specific horizontal and vertical groundwater gradients and the groundwater velocity within the aquifer to evaluate contaminant fate and transport
- Define the horizontal and vertical nature and extent of groundwater contaminated by site activities
- Define the lateral extent of NAPLs (if encountered)
- Determine groundwater flow directions and velocities

#### **3.3.5.1 MIPs Investigation**

The groundwater investigation will be conducted using direct push technology. MIPs will be used to measure vertical delineation of VOC contaminants. Select groundwater samples (approximately 10 percent) will be sent to a CLP laboratory as confirmation samples. The procedures and equipment applicable to the MIPs investigation are included in *FOP-04 Membrane Interface Probe Sample Collection*.

Groundwater grab samples will be collected from beneath the OMC Plant 2 and analyzed for VOCs. In addition, samples in the vicinity of the former plating and former foundry areas will also be analyzed for hexavalent chromium and filtered for dissolved metals analysis.

If NAPL is encountered, samples will be collected using a Teflon or stainless steel bailer or a peristaltic pump with Teflon tubing. The sampling will be conducted in such a manner as to minimize the amount of water collected when filling the sample containers. NAPL samples will be analyzed for VOCs and PCBs.

The MIPs data will be utilized to determine the locations (approximately five) of the temporary monitoring wells (1-inch diameter) to be placed within the building. The results of the groundwater samples collected from the temporary monitoring wells will be used to determine the locations (approximately 10) and depths for the new monitoring wells.

#### **3.3.5.2 Monitoring Well Installation**

Groundwater monitoring wells will be installed at approximately 10 locations to monitor groundwater quality and to collect data on hydrogeologic conditions at the Site. It is anticipated that each location will consist of a well nest including a shallow zone (0 to 10 feet) and a deep zone (20 to 30 feet) well. Monitoring wells will likely be installed using hollow-stem auger (HSA) drilling methods. The procedures and equipment applicable to these activities are specified in:

- *FOP-09 Monitoring Well Installation and Development*
- *FOP-05 Hollow-Stem Auger Drilling and Soil Sample Collection*
- *FOP-06 Monitoring Well and Soil Boring Abandonment*

#### **3.3.5.3 Groundwater Sampling**

Groundwater samples collected from new and existing wells will be sampled for VOCs, total cyanide, dissolved metals, and natural attenuation parameters (dissolved oxygen, pH, temperature, oxidation-reduction potential, conductivity, and specific conductance).

Groundwater analytical results will be compared to the Illinois TACO Tier I Groundwater Remediation Objectives for Groundwater Class I aquifers.

Groundwater samples will be collected from existing, temporary, and newly installed monitoring wells using low-flow methods. Specific equipment and procedures for low-flow groundwater sampling are presented in *FOP-11 Low-Flow Groundwater Sampling Procedures*. The procedures for field filtering groundwater samples are provided in *FOP-12 Groundwater Sample Filtration Procedures*.

If NAPL is encountered, samples will be collected using a Teflon or stainless steel bailer or a peristaltic pump with Teflon tubing. The sampling will be conducted in such a manner as to minimize the amount of water collected when filling the sample containers. NAPL samples will be analyzed for VOCs and PCBs.

#### **3.3.5.4 Water Level Measurements**

Groundwater level measurements will be collected to determine local groundwater flow directions and gradients. Depths to water will be measured with an electronic water-level indicator as described in *FOP-10 Groundwater Level Measurement*. In addition, an oil-water interface probe will be lowered to the bottom of the well to check for the presence or absence of NAPL in monitoring wells and to measure the total depth of the well. The well depth will be used to calculate the required purge volumes and assess the amount of solids collecting in the well.

### 3.3.5.5 In-situ Hydraulic Testing

In-situ hydraulic testing (i.e., slug testing) will be performed at all of the newly installed well locations to determine the site-specific hydraulic conductivity of the aquifer. The tests will consist of monitoring the aquifer response to a sudden change in hydraulic head (increasing and decreasing).

Prior to testing the wells, the water level will be measured to determine if the water level is above or within the screened interval of the well. If it is above, a falling-head slug test followed by a rising head test will be performed. If it is below, then two rising-head slug tests will be performed. The test procedures are described in *FOP-13 In Situ Hydraulic Testing*.

### 3.3.6 Soil Gas and Indoor Air Investigations

The objectives of the soil gas and indoor air sampling are to determine if volatilization from the chlorinated solvent plume has impacted soil gas levels south of the OMC plant in the vicinity of Larsen Marine and to characterize of indoor air VOC levels in the buildings currently utilized by Larsen Marine.

#### 3.3.6.1 Soil Gas Sampling

The soil gas sampling will be conducted using direct push technology. Temporary soil gas probes will be installed in the unsaturated zone at five locations. The gas probes will be constructed in such a manner as to allow soil gas sampling using Summa™ canisters. The procedures and equipment applicable to this activity are specified in:

- *FOP-03 Direct Push Soil Sample Collection*
- *FOP-21 Soil Gas Sample Collection Using Summa™ Canisters*

#### 3.3.6.2 Indoor Air Sampling

Ambient indoor air samples will be collected with the Larsen Marine buildings. Three sample locations—one from each of the main buildings on the Larsen Marine property—and one background sample will be collected and analyzed for VOCs. The air samples will be collected over an 8-hour period during nonworking hours. The procedures and equipment applicable to this activity are specified in *FOP-20 Indoor Air Sample Collection*.

### 3.3.7 Surveying

A licensed surveyor will survey the soil sampling and monitoring well locations and the elevation of the monitoring well casings. The horizontal position of the various sampling/monitoring locations will be established to within 0.1 foot using (latitude and longitude in decimal degrees and Universal Transverse Mercator North American Datum 83 (UTM) coordinates. Elevations will be established within 0.01 foot based on North American Vertical Datum (NAVD).

### 3.3.8 IDW Sampling

Materials that may become IDW requiring proper treatment, storage, and disposal are:

- Personnel protective equipment (PPE). This includes disposable coveralls, gloves, booties, respirator canisters, etc.



- Disposable equipment (DE). This includes plastic ground and equipment covers, aluminum foil, Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.
- Soil cuttings from drilling or hand augering
- Groundwater obtained through well development or well purging
- Decontamination water

The solid and liquid IDW generated during the field work will be containerized, sampled, characterized, and disposed of following the completion of RI activities. CH2M HILL assumes that all solid wastes generated will be disposed of at a licensed municipal landfill and all liquid wastes will be disposed of to the North Shore Sanitary District.

PPE, after decontamination, will be treated as debris and will be placed in a dumpster. PPE that is not decontaminated will be stored in 55-gallon drums. This waste will be disposed of in accordance with the procedures presented in *the Waste Transportation and Disposal Plan*.

### **3.3.9 Demobilization**

Upon conclusion of the field activities, all of the support facilities and equipment from the site will be demobilized. All equipment and tools will be properly decontaminated before they are demobilized from the area. No site restoration activities are anticipated other than those required at sampling locations.

## SECTION 4

# General Field Operations

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## 4.1 Sample Management

The section describes the procedures to be implemented so that once representative environmental samples are obtained, they are properly containerized, preserved, shipped, and otherwise handled in a manner that will maintain sample integrity. The use of these techniques will provide representative samples and will reduce the possibility of sample contamination from external sources.

### 4.1.1 Sample Identification

A sample numbering system will be used to identify each sample, including duplicate and blank samples. The sample number used will enable each sample to have a unique identifier, required by Earthsoft's EQuIS Site Management software, that is compatible with USEPA's EDMAN EDD deliverable format.

Each sample to be analyzed by the CLP will be assigned a unique CLP sample number and will be analyzed by a designated laboratory under an assigned Case Number. The CLP sample numbers are obtained from a block of numbers provided by the Region 5 RSCC.

Samples analyzed by an independent laboratory outside the CLP program will be assigned a unique sample number made up of a Special Analytical Services (SAS) number followed by a unique two-digit sequential numerical suffix. The SAS numbers are assigned by the CH2M HILL sample coordinator.

Each sample, regardless of analytical protocol, will also be assigned a CH2M HILL site-specific identifier that will contain a project identification code (identifying OMC as the Outboard Marine Corporation Plant 2 site), and a sample-specific station location identifier, which tells where the sample was collected. Samples collected from monitoring wells will use a station location identifier that includes the well ID and the sampling round. Other samples will use a sequential numbering system which will include, if applicable, the sample depth (e.g., soil or sediment).

The sample number and station location identifier will be included on the sample tag and the traffic report/chain-of-custody record.

The site-specific identifier will be based on the following system:

- **Site** – Always OMC (included to differentiate from previous investigation locations)
- **Station Location** – The station location identifier is the unique name of the sampling location (e.g., soil boring, monitoring well, etc.). The location name will vary depending on the reason for sampling and the numeric location number assigned to that location. The location name is five characters long; two letters followed by three numerals. The two letters will indicate one of the following types of sample locations:
  - **SO** – Direct push or auger boring location (differentiates from borings conducted during previous investigations that were labeled "SB")

- **MW**—Monitoring well
- **GW**—Groundwater grab samples
- **AA**—Ambient air samples
- **GS**—Soil gas samples
- **TB**—Trip blank
- **FB**—Field blank
- **EB**—Equipment blank
- **CB**—Concrete boring
- **WA**—Investigation derived waste
- **WP**—Wipe samples

The three numerals, following the two-letter sample type, will consist of a location number sequentially generated based upon the order which the sampling is performed. For example, the third soil sample location would be SO003, and a sample from monitoring well 10 would be MW010. Where a number of different sample types will be collected at a single location, the station location number shall be duplicated for each sample type collected at that location.

- **Depth Indicator**—Depth indicator codes, if applicable, will follow the station location as indicated below:
  - **Soil and Groundwater Grab Samples and Soil Gas Samples**—the sample depth will be appended to the station location and consist of a hyphen followed by the starting and bottom depth intervals separated by a slash. This indicator will provide the depth that represents the start and end of the sample interval in feet below ground surface (bgs). For example the sample depth designation will be “-05/7.5” for the sample collected from an interval of 5 to 7.5 feet bgs.
  - **Monitoring Well Samples**—the code used for the depth of a well will consist of a single alpha character indicating the aquifer where the well is screened. Typically, an “S,” “I,” or “D” will identify shallow, intermediate, and deep zone wells. If existing wells are named using an alternate code (e.g., “U” for upper zone or “L” for lower zone), these codes will be used to show well depth to prevent confusion of the well identity. This is followed by a hyphenated sequence indicator to indicate the number of the sampling event. For example, the first sample from the shallow monitoring well in well nest 102 would be named “OMC-MW102S-01”
- **QA/QC Identifier**—Field QA/QC samples will be identified using the following QA/QC identifiers:
  - Field blanks, which are not associated with an individual station location, are numbered sequentially and are identified by the first two letters of the station location code (e.g. EB001 is an equipment blank, TB025 is a trip blank).

- Field duplicates, which are associated with the same station location as the native sample, are identified with an “R” (for “replicate”) appended to the end of the location code. For example, the duplicate of sample OMC-SO002-05 would be labeled OMC-SO002-05R.
- **Laboratory QA/QC Samples**— A sample collected for laboratory QC (laboratory spike samples) is considered to be a single sample, even though additional volume is provided to the laboratory. Consequently, all laboratory QC samples are assigned a single sample number and station location identifier. Laboratory QC samples are not identified in the station location code, but rather are called out on the chain-of-custody form in the “*Samples to be used for laboratory QC*” field and on the sample tag.

### 4.1.2 Sample Containers

The contaminant-free sample containers (bottles) used in this sampling effort will be purchased from an approved vendor or prepared by the subcontracted laboratory. All sample containers for laboratory analyses will meet or exceed the USEPA requirements specified in OSWER Directive #9240-05A, *Specifications and Guidance for Obtaining Contaminant-Free Containers* (April 1990). Bottles used for the sampling activity will not contain target organic and inorganic contaminants exceeding the level specified in the above mentioned document. Specifications for the bottles will be verified by checking the supplier’s certified statement and analytical results for each bottle lot.

Equipment (field) blanks, trip blanks, etc., will be used to monitor for contamination. Corrective actions will be taken as soon as a problem is identified and may include:

- Discontinuing the use of a specific bottle lot
- Contacting the bottle supplier(s) for re-testing the representative bottle from a suspect lot
- Assessing decontamination procedures
- Re-sampling the suspected samples
- Validating the data

Table 4-1 presents a summary of the sample containers needed for the various field investigations to be performed as part of the RI.

### 4.1.3 Sample Preservation and Holding Times

Sample containers, preservatives and sample holding times will meet the requirements set forth by the USEPA. Sample containers will be certified by the laboratories or vendors as pre-cleaned. Chemical preservatives will be added to certain aqueous samples in accordance with the USEPA guidelines to retard sample degradation during storage and shipment prior to laboratory analysis. Sample bottles received from the CH2M HILL subcontracted laboratory will be pre-preserved by the laboratory before shipment to the field team. In addition to chemical preservatives, all samples for chemical analysis will be transported to the laboratory in temperature controlled coolers. Ice will be used to maintain the internal cooler temperature at  $4 \pm 2^{\circ}\text{C}$  during sample collection and shipment to the laboratory. A summary of preservation/storage requirements and holding times for the analyses to be performed are provided in Table 4-1.



Filtered groundwater may be submitted for metals analyses if turbidity levels cannot be reduced during purging. Filtering will occur in the field during sample collection. Samples will be filtered through a 0.45 micron filter following procedures located in *FOP-12 Groundwater Sample Filtration Procedures*.

#### **4.1.4 Sample Handling, Packaging and Shipment**

Sample handling, packaging and shipping procedures are described in *FOP-14 Sample Handling, Packaging, and Shipping*.

Sample coolers will be shipped to arrive at the CLP or independent laboratories the morning after sampling (priority overnight) or will be sent by a courier to arrive the same day. For non-CLP samples analyzed at an independent laboratory, the laboratory will be notified of the sample shipment and the estimated date of arrival of the samples being delivered.

### **4.2 Field Activity Documentation and Logbook**

Several procedures will be implemented by CH2M HILL to document the location, media and parameters of samples collected in the field. These procedures include a bound field logbook maintained to record the acquisition of each sample, both for CLP and independent laboratory analysis; sampling locations be photographed; COC forms for all environmental samples and field QC samples be completed; parameter data generated as a result of sampling activities be maintained on file; and sampling locations be surveyed relative to the state datum (and UTM coordinates) in addition to noting the sample locations on site drawings with respect to permanent landmarks or site features. The following describes the sample documentation methods that will be used at the OMC site.

#### **4.2.1 Field Logbook**

A field sampling logbook will be initiated at the start of the first onsite activity and maintained to document field activities throughout the field effort in accordance with *FOP-15 Field Logbook*.

#### **4.2.2 Photographic Documentation**

The FTL or his designee will selectively photograph field activities to complement descriptions of field activities in the field logbook. The following information will be recorded in the logbook when photographs are taken:

- Date and time
- Exposure number/roll number or digital file name
- Location of the photograph
- Description and identification of the subject
- The initials of the person who took the photograph.

Photographs will be maintained by the CH2M HILL for reference during the project. At the submission of a final report, CH2M HILL will deliver the captioned photographs in an album to the USEPA.

### 4.2.3 Sample Chain-of-Custody

For samples collected for analysis, the USEPA chain-of-custody (COC) protocols will be followed, as described in the *National Enforcement Investigations Center (NEIC) Policies and Procedures*, EPA-330/9-78-DDI-R, Rev. June 1985. COC forms will be completed through the use of USEPA's Field Operations Reporting Management System (FORMS) II Lite software program. Custody procedures are described in Section 2.3.2 of the QAPP. The protocol for filling out the COC is provided in *FOP-16 Documentation/Chain-of-Custody Procedure*.

## 4.3 Field Parameter Documentation

Information collected in the field through visual observation, manual measurement, and/or field instrumentation will be recorded in field notebooks, data sheets, and/or forms and then entered into an electronic data log. Data will be reviewed by the FTL for adherence to the QAPP/SAP and consistency of data. Any concerns identified will be corrected and incorporated into the data evaluation process.

Field data calculations, transfers, and interpretations conducted by the field team will also be reviewed by the FTL. The field data logs and documents will be checked for the following:

- General completeness
- Readability
- Use of appropriate procedures and modifications to sampling procedures are clearly stated
- Appropriate instrument calibration and maintenance records (as appropriate)
- Reasonability of data collected
- Correctness of sample locations
- Correctness of reporting units, calculations, and interpretations

Where appropriate, field data forms and calculations will be processed and included in appendices to the appropriate report. Original field logs, documents, and data reductions will be kept in the project file.

## 4.4 Quality Control Sample Procedures

Each of the offsite laboratories identified in the QAPP will have a QC program to ensure the reliability and validity of the analyses being performed. QC procedures for photoionization detector (PID), pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductance, and temperature measurements include calibrating the instruments (see *FOP-19 Equipment Calibration*), measuring duplicate samples and checking the reproducibility of the measurements by taking multiple readings from a single sample. Field sampling precision and bias will be evaluated by collecting field duplicate and equipment (field) blanks for laboratory analysis.

### 4.4.1 Decontamination and Drilling Water

Water will be used to decontaminate sampling equipment (e.g., stainless-steel trays, split-spoons) after each use and may be used for drilling purposes. In order to ensure that this water will not cause cross-contamination, the source water will be demonstrated to be

analyte-free prior to performance of environmental sampling. The criteria for analyte-free water will be determined by the detection limits of the laboratory methods used for analysis of the sample analytes.

If water used for the above noted purposes is found to contain common laboratory contaminants (methylene chloride, toluene, acetone, 2-butanone, and phthalate esters) or contaminants related to potable water chlorination at concentrations less than ten times the concentration detected in a blank (i.e., trip blank, rinsate blank), the water will be considered appropriate for use for drilling and decontamination purposes.

#### **4.4.2 Field Duplicates**

Field duplicate samples will be used to measure the heterogeneity of the sample matrix and the precision of the field sampling and analytical process. Duplicate samples will be collected at a frequency of one duplicate per 10 samples per sampling technique collected for each medium.

For soils, field duplicate samples will be collected by placing the soil in a decontaminated stainless steel bowl, mixing the sample by stirring, and then filling the individual sample and duplicate containers from the bowl. VOC soil duplicate samples will not be collected in this manner. VOC soil duplicates samples will be obtained first by collecting the original sample and then collecting the duplicate sample as close as possible to the original sample.

Groundwater field duplicate samples will be collected by alternately filling first the sample bottle for one analysis and then the duplicate bottle for one analysis. This procedure will be followed until the bottles for all analyses are filled. If dissolved metals samples are collected, a separate inline filter will be used to fill the sample and duplicate containers.

The sample bottles will be labeled as described in this plan. The samples will be preserved and stored in the same manner as the field samples. The frequency of collection will be at least 10 percent.

Wipe sample field duplicates will be collected by locating a compact, contiguous and homogeneous area where a representative wipe sample can be collected. Collect the wipe sample and the duplicate wipe sample within designated sample area using alternating wipe paths, taking care to avoid any overlap.

Concrete core sample field duplicates will be collected from the same core or from multiple cores collected as close to together as possible. The sampling approach will be documented in the field log book.

#### **4.4.3 Equipment Blanks**

Equipment (field) blanks will be collected and analyzed to determine whether the decontamination procedure has been adequately performed and that there is no cross-contamination of samples occurring due to the equipment or residual decontamination solutions. Equipment blanks will be collected for all matrices to be sampled. A consistent volume of demonstrated analyte-free distilled and deionized water will be poured directly into or over the decontaminated sampling equipment and then collected in a sample container. The sample bottles will be labeled as described in the plan. The samples will be preserved and handled in the same manner as the groundwater samples. The frequency of collection will be at least 5 percent.

#### 4.4.4 Trip Blanks

Trip blanks will be used to determine if any on-site atmospheric contaminants are seeping into the sample bottles, or if any cross-contamination of samples is occurring during shipment or storage of sample containers. Aqueous trip blanks will be included with both groundwater and soil VOC samples.

Aqueous trip blanks will consist of demonstrated analyte-free distilled and deionized water preserved with 1:1 HCl to a pH of less than or equal to 2 standard units in 40 mL Teflon-lined septum vials. One set of trip blanks will accompany each sample cooler containing one or more VOC samples. The sample bottles will be labeled as described in this plan. The samples will be stored in the same manner as the groundwater samples.

#### 4.4.5 Matrix Spike/Matrix Spike Duplicate

Matrix spike/matrix spike duplicate (MS/MSD) samples will be used by the laboratories to assess the precision and accuracy of sample analysis. The MS/MSD samples will be fortified by the laboratories in accordance with the specifications of the analytical methods.

Two extra volumes of sample are required for each combination of MS/MSD samples. Sample containers will be filled and stored in the same manner as field duplicate samples. The frequency for collection of MS/MSD samples will be at least 5 percent.

#### 4.4.6 Temperature Blanks

A temperature blank will be included in each cooler to allow the laboratory receiving the shipment of samples to determine if the samples have been maintained at the proper temperature. Temperature blanks will consist of a unpreserved sample container filled with distilled water. One temperature blank will accompany each sample cooler being shipped to the laboratory.

### 4.5 Decontamination Procedures

Decontamination of personnel, sampling, monitoring and heavy equipment will follow the procedures presented in *FOP-17 Decontamination of Drilling Rigs and Equipment* and *FOP-18 Decontamination of Personnel and Equipment*. The potable water to be used in equipment decontamination will be either from bottles or from a public water supply system. A sample of the water from each source used will be collected at the time of its first use and sent for VOCs, SVOCs, and metals analyses.

### 4.6 Disposal of RI-Generated Wastes

The waste materials generated during a field investigation are known as investigation derived wastes (IDW). Materials, which may become IDW requiring proper treatment, storage and disposal are:

- Personnel protective equipment (PPE). This includes disposable coveralls, gloves, booties, respirator canisters, etc.



- Disposable equipment (DE). This includes plastic ground and equipment covers, aluminum foil, Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.
- Soil cuttings from drilling, probing, or hand auguring
- Groundwater obtained through well development or well purging
- Decontamination water

Management of IDW and materials will be performed consistent with the USEPA guidance *Guide to Management of Investigation – Derived Wastes*, 9345.3-03FS, dated January 1992.

Disposable equipment (including personal protective equipment) and debris will be containerized and appropriately labeled during the sampling events, and will be disposed of accordingly. All purged groundwater and water generated during equipment decontamination will be containerized and staged onsite in a 55-gallon drum or “poly” tank, and will be disposed of appropriately based on analytical results. Equipment will be decontaminated as appropriate, as discussed in *FOP-17 Decontamination of Drilling Rigs and Equipment* and *FOP-18 Decontamination of Personnel and Equipment*. All soil cuttings associated with drilling, direct push technologies, and other subsurface investigations will also be collected and stored onsite in a 55-gallon drum or “roll-off” box and disposed of accordingly following receipt of analytical results. OMC Plant 2 will include support facilities for material storage and staging.

## 4.7 Field Monitoring Instrumentation

Numerous monitoring instruments will be used during RI activities. These include the following:

- Water quality meter(s) which measure pH, specific conductance, temperature, turbidity, dissolved oxygen, and oxidation reduction potential
- Photoionization detectors
- Combustible gas/oxygen/hydrogen sulfide monitors
- Electronic water level indicators

Each device will be calibrated according to the manufacturer's operating manual prior to each day's use as specified in *FOP-19 Equipment Calibration* and in the site-specific *Health and Safety Plan*.

Calibration of the equipment will be documented in the field logbook or in an equipment calibration log. During calibration an appropriate maintenance check will be performed on each piece of equipment. If damaged or failed parts are identified during the daily maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service and replaced until the identified parts are repaired or replaced.

**TABLE 4-1**  
**Sample Containers, Preservatives, and Holding Times**  
**OMC Plant 2**

<b>Analysis</b>	<b>Method a, d</b>	<b>Container</b>	<b>Preservation/ Storage</b>	<b>Maximum Hold Time</b>
<b>Building (core samples)</b>				
TAL Metals	ILM05.3	Concrete core plug in ziploc bag	4°C	180 days; mercury 28 days
Cyanide (total)	ILM05.3	Concrete core plug in ziploc bag	4°C	14 days
TCL PCBs	OLM04.2	Concrete core plug in ziploc bag	4°C	14 days
SPLP Metals (including Be)	SW-836 1312/6010	Concrete core plug in ziploc bag	4°C	180 days
SPLP PCBs	SW-846 1312 <sup>a</sup> /8082	Concrete core plug in ziploc bag	4°C	14 days
<b>Building (wipe samples)</b>				
TCL PCBs	OLM04.2	Cotton Gauze + 40-mL glass jar	4°C, 15 mL hexane	14 days
<b>Soil</b>				
TAL Metals	ILM05.3	One 8-oz amber glass	4°C	180 days; mercury 28 days
Cyanide (total)	ILM05.3	One 8-oz amber glass	4°C	14 days
TCL PCBs	OLM04.2	One 8-oz amber glass	4°C	14 days
TCL VOCs	OLM04.2	One 2-oz or 4-oz glass – no head space (must have 5g of soil)	4°C, MeOH	14 days
TCL SVOCs	OLM04.2	One 8-oz amber glass	4°C	14 days
SPLP PCBs	SW-846 1312 <sup>a</sup> /8082	One 8-oz amber glass	4°C	14 days
SPLP Metals (including Be)	SW-836 1312/6010 or 7000 series (Mercury)	One 8-oz amber glass	4°C	180 days; mercury 28 days
Total Organic Carbon	415.1 or SW-846 9060	One 8-oz amber glass	4°C	48 hours
Porosity	ASTM D4404-84	4-oz glass jar	—	—
Bulk Density	ASTM D854 (Specific Gravity)	4-oz glass jar	—	—
Grain Size	ASTM D422-63	4-oz glass jar	—	—
Moisture Content	EPA 160.3	4-oz glass jar	4°C	—
Soil Oxidant Demand <sup>b</sup>	Potassium Permanganate Demand	4-oz glass jar	4°C	Upon receipt of samples

**TABLE 4-1**  
Sample Containers, Preservatives, and Holding Times  
OMC Plant 2

Analysis	Method a, d	Container	Preservation/ Storage	Maximum Hold Time
<b>Groundwater</b>				
TCL PCBs	OLC03.2	Two 1-L amber glass	4°C	7 days to extraction, 40 days from extraction to analysis
TCL VOCs	OLC03.2	Three 40-mL VOA vials	HCl to pH ≤ 2, 4°C	7 days to extraction, 40 days from extraction to analysis
TCL SVOCs	OLC03.2	Two 1-L amber glass	4°C	7 days to extraction, 40 days from extraction to analysis
TAL Metals (total and dissolved)	ILM05.3	1-L poly	HNO <sub>3</sub> to pH ≤ 2	180 days; mercury 28 days
Cyanide (total)	ILM05.3	1-L poly	NaOH to pH ≥ 12	14 days
Chromium (hexavalent)	SW-846 7196	250-mL poly	4°C	24 hours
Sulfate <sup>c</sup>	EPA 375.4	250-mL poly	4°C	28 days
Sulfide <sup>c</sup>	EPA 376.1	500-mL poly	4°C, Zn acetate, NaOH to pH > 9	7 days
Nitrate <sup>c</sup>	EPA 300.0	100-mL poly	4°C	48 hours
Chloride <sup>c</sup>	EPA 300.0	250-mL poly	4°C	28 days
Methane/Ethane/ Ethane <sup>c</sup>	RSK 175	Three 40mL VOA vials	4°C	14 days
Total Alkalinity <sup>c</sup>	EPA 310.2	100-mL poly	4°C	14 days
TOC <sup>c</sup>	SW-846 9060	100-mL poly	HCl to pH < 2, 4°C	28 days
Nitrite <sup>c</sup>	EPA 354.1	100-mL poly	4°C	48 hours
<b>Investigation Derived Waste (characterization sampling)</b>				
<b>Soil</b>				
TCLP VOCs	SW 846 1311/8260B	One 2-oz or 4-oz glass – no head space (must have 5g of soil)	4°C, MeOH	14 days
TCLP SVOCs	SW-846 1311/8270C	One 8-oz amber glass	4°C	14 days
TCLP Pesticides	SW-846 1311/8081A	One 8-oz amber glass	4°C	14 days
TCLP Metals	SW-846 1311/6010B or 7000 series (Mercury)	One 8-oz amber glass	4°C	180 days; mercury 28 days
TCL VOCs	OLM04.2	One 2-oz glass – no head space	4°C, MeOH	14 days
TCL SVOCs	OLM04.2	One 8-oz amber glass	4°C	14 days

**TABLE 4-1**  
Sample Containers, Preservatives, and Holding Times  
OMC Plant 2

Analysis	Method a, d	Container	Preservation/ Storage	Maximum Hold Time
TCL Pesticides	OLM04.2	One 8-oz amber glass	4°C	14 days
TCL PCBs	OLM04.2	One 8-oz amber glass	4°C	14 days
TAL Metals	ILM05.3	One 8-oz amber glass	4°C	180 days; mercury 28 days
Cyanide	ILM05.3	One 8-oz amber glass	4°C	14 days
<b>Investigation-Derived Waste (characterization sampling)</b>				
<b>Groundwater</b>				
TCL VOCs	OLM04.3	Three 40-mL VOA vials	HCl to pH ≤ 2, 4°C	7 days to extraction, 40 days from extraction to analysis
TCL SVOCs	OLM04.3	Two 1-L amber glass	4°C	7 days to extraction, 40 days from extraction to analysis
TCL Pesticides	OLM04.3	Two 1-L amber glass	4°C	7 days to extraction, 40 days from extraction to analysis
TCL PCBs	OLM04.3	Two 1-L amber glass	4°C	7 days to extraction, 40 days from extraction to analysis
TAL Metals	ILM05.3	1-L poly	HNO <sub>3</sub> to pH ≤ 2	180 days; mercury 28 days
Cyanide (total)	ILM05.3	1-L poly	NaOH to pH ≥ 12	14 days
<b>Soil Gas &amp; Air</b>				
VOCs	TO-15	SUMMA canister	None	14 days

a. Identified method may be modified in QAPP based on quantitation limits to achieve Illinois TACO Tier 1 remediation objectives or ADLs.

b. Soil Oxidant Demand – Analysis, containers, storage, and holding times are different depending on laboratory used.

c. Indicates natural attenuation parameter selected from Table 2.3 of EPA's *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, 1998.

d. CLP method listed or equivalent

— = not applicable/not required

## SECTION 5

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## 5.1 OMC Files

The following items were obtained from OMC files and were not attached to any documents that could be referenced.

### 5.1.1 Tables

In-Service Transformer Inventory. nd.

### 5.1.2 Plates or Figures

Clark, Dietz & Associates Engineers, Inc. Plant Outfalls & General Drainage Patterns, Johnson Outboards, Waukegan, Illinois. April 1980.

EPA Degreaser Retrofit Program. nd.

EPA Sludge Sampling Locations (B-PP-4). June 9, 1976.

Figure A-1 Transformer Locations. nd.

Johnson Motors Plant 2, Mid & Corp. Sewer Layout (D-BL2-22). Scale 1"=25'-0", 4-8-74. Revised April 1976.

Johnson Motors Plant 2, Die Cast Sewer Layout (D-BL2-21). Scale 1"=25'-0", 4-11-74, Revised April 1976.

Plant #2 Water & Sprinkler (D-BL2-2). Scale 1 Inch = 50 feet, May 6, 1973, Revised December 20, 1979.

Sanitary Sewer Discharges (B-PP-3), Revised October 1971.

### 5.1.3 Other

Outboard Marine Corporation (OMC). Appropriation Request No. 6335—Permachlor Storage Tank (Replacement). Prepared March 19, 1971.

## **Appendix A**

### **Source Data**

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## APPENDIX A

# Source Data

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Summary tables of the analytical data from the previous investigations conducted at the site and included in the site database are provided in this appendix. These data were used to develop the conceptual model of the chemical conditions existing at the OMC Plant 2 site.

The analytical results from the following sources are attached:

Date	Author	Title/Subject
December 3, 1996	OMC	Meeting Agenda, 12/03/96 – 2:00 PM
July 9, 1997	Lorrie Franklin/ First Environmental Laboratories, Inc.	Analytical Results
August 12, 1997	GZA GeoEnvironmental, Inc.	In-Field Analytical Survey, OMC – Waukegan Illinois
September 17, 1997	Lorrie Franklin/ First Environmental Laboratories, Inc.	Analytical Results
October 3, 1997	Golder Associates	Results of Hydropunch Survey, UST Assessment, OMC Waukegan Plant 2
December 8, 1997	Ann Arbor Technical Services, Inc. (ATS)	1994 Soil Reconnaissance Survey, OMC-Plant #2 Die Cast UST Area, 90 Seahorse Drive, Waukegan, Illinois
December 29, 1998	First Environmental Laboratories, Inc.	Analytical Results
January 5, 1999	Rebecca J. Hans/ Microseeps	Final data for samples received on December 12, 1998
September 20, 1999	STS Consultants, Ltd.	Environmental Characterization Activities at the Outboard Marine Corporation's Plant 2 Die Cast Facility Located in Waukegan, Illinois
August 29, 2001	Camp Dresser & McKee Inc.  (Note: report prepared for Illinois Department of Natural Resources)	Limited Phase II Environmental Site Assessment, Waukegan North Beach PCB Investigation Near North Beach Park, Waukegan, Illinois
May 19, 2002	Tetra Tech EM, Inc.	Discovery Site Visit Report, Outboard Marine Corporation, Waukegan, Lake County, Illinois
December 12, 2003	Tetra Tech EM, Inc.	EPA Removal Action Summary Report

**OMC Meeting Notes**  
**(December 1996)**

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# VOC Results in Water

(Results from OMC, 1996)

Location:	W-09-95	W-10-95	W-11-95	W-12-95	NONE	W-05-96
Sample Matrix:	WG	WG	WG	WG	WG	WG
Sample Date:	05/25/1995	05/26/1995	05/26/1995	05/25/1995	08/29/1995	10/11/1996
Sample ID:	W-09	W-10	W-11	W-12	West RW-E	W-05
Depth (ft):	13-28	16-25	22-27	10-25	-	26-31

## VOCs (ug/L)

1,1,2,2-TETRACHLOROETHANE	5U	5U	5U	5U	5U	5U
1,1,2-TRICHLOROETHANE	5U	5U	5U	5U	5U	5U
1,2,4-TRIMETHYLBENZENE						5U
1,2-DICHLOROPROPANE	5U	5U	5U	5U	5U	5U
1,3,5-TRIMETHYLBENZENE(MESITYLENE)						5U
2-HEXANONE	10U	10U	10U	10U	10U	10U
ACETONE	100U	100U	100U	100U	100U	100U
BROMODICHLOROMETHANE	5U	5U	5U	5U	5U	5U
BROMOFORM	5U	5U	5U	5U	5U	5U
BROMOMETHANE	10U	10U	10U	10U	10U	10U
CARBONTETRACHLORIDE	5U	5U	5U	5U	5U	5U
CHLOROBENZENE	5U	5U	5U	5U	5U	5U
CHLOROFORM	5U	5U	5U	5U	5U	5U
CHLOROMETHANE	10U	10U	10U	10U	10U	10U
CIS-1,3-DICHLOROPROPENE	5U	5U	5U		5U	5U
DIBROMOCHLOROMETHANE	5U	5U	5U	5U	5U	5U
DICHLORODIFLUOROMETHANE						10U
METHYLENECHLORIDE	5U	5U	5U	5U	5U	5U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)	10U	10U	10U	10U	10U	10U
STYRENE	5U	5U	5U	5U	5U	5U
TRANS-1,3-DICHLOROPROPENE	5U	5U	5U	5U	5U	5U
VINYLACETATE	10U	10U	10U	10U	10U	10U



**VOC Results in Water**

(Results from OMC, 1996)

Location:	W-06-96	W-09-96	W-10E
Sample Matrix:	WG	WG	WG
Sample Date:	10/11/1996	10/11/1996	10/11/1996
Sample ID:	W-06	W-09D	W-10E
Depth (ft):	25-32	13-28	-

**VOCs (ug/L)**

1,1,2,2-TETRACHLOROETHANE	5U	5U	5U
1,1,2-TRICHLOROETHANE	5U	5U	5U
1,2,4-TRIMETHYLBENZENE	5U	5U	5U
1,2-DICHLOROPROPANE	5U	5U	5U
1,3,5-TRIMETHYLBENZENE(MESITYLENE)	5U	5U	5U
2-HEXANONE	10U	10U	10U
ACETONE	100U	100U	100U
BROMODICHLOROMETHANE	5U	5U	5U
BROMOFORM	5U	5U	5U
BROMOMETHANE	10U	10U	10U
CARBONTETRACHLORIDE	5U	5U	5U
CHLOROBENZENE	5U	5U	5U
CHLOROFORM	5U	5U	5U
CHLOROMETHANE	10U	10U	10U
CIS-1,3-DICHLOROPROPENE	5U	5U	5U
DIBROMOCHLOROMETHANE	5U	5U	5U
DICHLORODIFLUOROMETHANE	10U	10U	
METHYLENECHLORIDE	5U	5U	5U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)	10U	10U	10U
STYRENE	5U	5U	5U
TRANS-1,3-DICHLOROPROPENE	5U	5U	5U
VINYLACETATE	10U	10U	10U

**VOC Results in Water**

(Results from OMC, 1996)

Location:	W-09-95	W-10-95	W-11-95	W-12-95	NONE	W-05-96
Sample Matrix:	WG	WG	WG	WG	WG	WG
Sample Date:	05/25/1995	05/26/1995	05/26/1995	05/25/1995	08/29/1995	10/11/1996
Sample ID:	W-09	W-10	W-11	W-12	West RW-E	W-05
Depth (ft):	13-28	16-25	22-27	10-25	-	26-31

**VOCs Continued (ug/L)**

1,2,4-TRICHLOROBENZENE	5U
1,2-DICHLOROBENZENE	5U
1,3-DICHLOROBENZENE	5U
1,4-DICHLOROBENZENE	5U
HEXACHLOROBUTADIENE	5U
NAPHTHALENE	10U

**VOC Results in Water**  
**(Results from OMC, 1996)**

	<b>Location:</b>	<b>W-06-96</b>	<b>W-09-96</b>	<b>W-10E</b>
	<b>Sample Matrix:</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>
	<b>Sample Date:</b>	<b>10/11/1996</b>	<b>10/11/1996</b>	<b>10/11/1996</b>
	<b>Sample ID:</b>	<b>W-06</b>	<b>W-09D</b>	<b>W-10E</b>
	<b>Depth (ft):</b>	<b>25-32</b>	<b>13-28</b>	<b>-</b>
<b>VOCs (ug/L)</b>				
1,2,4-TRICHLOROBENZENE		5U	5U	5U
1,2-DICHLOROBENZENE		5U	5U	5U
1,3-DICHLOROBENZENE		5U	5U	5U
1,4-DICHLOROBENZENE		5U	5U	5U
HEXACHLOROBUTADIENE		5U	5U	5U
NAPHTHALENE		10U	10U	10U

**VOC Results in Water**  
(Results from OMC, 1996)

	Location:	W-09-95	W-10-95	W-11-95	W-12-95	NONE	W-05-96
	Sample Matrix:	WG	WG	WG	WG	WG	WG
	Sample Date:	05/25/1995	05/26/1995	05/26/1995	05/25/1995	08/29/1995	10/11/1996
	Sample ID:	W-09	W-10	W-11	W-12	West RW-E	W-05
	Depth (ft):	13-28	16-25	22-27	10-25	-	26-31
<b>CVOC (ug/L)</b>							
1,1,1-TRICHLOROETHANE		5U	5U	5U	5U	5U	5U
1,1-DICHLOROETHANE		31E	5U	5U	17	6	1100D
1,1-DICHLOROETHENE		41E	5U	5U	5U	5	53
1,2-DICHLOROETHANE		5U	5U	5U	5U	5U	5U
CHLOROETHANE		10U	10U	10U	10U	10U	10U
CIS-1,2-DICHLOROETHYLENE		22000	1600	5U	110	790	30000D
TETRACHLOROETHYLENE(PCE)		5U	5U	5U	5U	5U	5U
TRANS-1,2-DICHLOROETHENE		29E	7	5U	5U	5U	53
TRICHLOROETHYLENE(TCE)		5	16	5U	5U	610	5U
VINYLCHLORIDE		2100	10U	10U	10U	240	3700D
<b>BTEX (ug/L)</b>							
BENZENE		5U	5U	5U	8	11	5U
ETHYLBENZENE		5U	5U	5U	5U	5U	5U
M-XYLENE(1,3-DIMETHYLBENZENE)							5U
O-XYLENE(1,2-DIMETHYLBENZENE)							5U
P-XYLENE(1,4-DIMETHYLBENZENE)							5U
TOLUENE		5U	5U	5U	5U	5U	5U
XYLENES,TOTAL		5U	5U	5U	5U	5U	

**VOC Results in Water**  
(Results from OMC, 1996)

Location:	W-06-96	W-09-96	W-10E
Sample Matrix:	WG	WG	WG
Sample Date:	10/11/1996	10/11/1996	10/11/1996
Sample ID:	W-06	W-09D	W-10E
Depth (ft):	25-32	13-28	-

**CVOC (ug/L)**

1,1,1-TRICHLOROETHANE	5U	5U	5U
1,1-DICHLOROETHANE	1500D	88	5U
1,1-DICHLOROETHENE	5U	140	5U
1,2-DICHLOROETHANE	5U	5U	5U
CHLOROETHANE	10U	10U	10U
CIS-1,2-DICHLOROETHYLENE	50000D	31000D	1500D
TETRACHLOROETHYLENE(PCE)	5U	5U	5U
TRANS-1,2-DICHLOROETHENE	61	70	7
TRICHLOROETHYLENE(TCE)	5U	5U	240D
VINYLCHLORIDE	3700D	3600D	10U

**BTEX (ug/L)**

BENZENE	5U	5U	5U
ETHYLBENZENE	5U	5U	5U
M-XYLENE(1,3-DIMETHYLBENZENE)	5U	5U	5U
O-XYLENE(1,2-DIMETHYLBENZENE)	5U	5U	5U
P-XYLENE(1,4-DIMETHYLBENZENE)	5U	5U	5U
TOLUENE	5U	5U	5U
XYLENES,TOTAL			



**First Environmental Laboratories**  
**(July 1998)**

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**VOC Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	HY-34-98	HY-34-98	HY-34-98	HY-35-98	HY-35-98	HY-36-98	HY-36-98
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	12/09/1998	12/09/1998	12/09/1998	12/10/1998	12/10/1998	12/09/1998	12/09/1998
	Sample ID:	67907	67908	67909	68142	68143	67905	67906
	Depth (ft):	15-17	15-17	25-27	15-17	25-27	15-17	25-27
<b>VOCs (ug/L)</b>								
1,1,2,2-TETRACHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
1,1,2-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
1,2-DICHLOROPROPANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
BROMODICHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
BROMOFORM		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
BROMOMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
CARBONDISULFIDE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CARBONTETRACHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROFORM		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
CIS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
DIBROMOCHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
METHYLENECHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
METHYLETHYLKETONE(2-BUTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
VINYLACETATE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U

**VOC Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	HY-34-98	HY-34-98	HY-34-98	HY-35-98	HY-35-98	HY-36-98	HY-36-98
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	12/09/1998	12/09/1998	12/09/1998	12/10/1998	12/10/1998	12/09/1998	12/09/1998
	Sample ID:	67907	67908	67909	68142	68143	67905	67906
	Depth (ft):	15-17	15-17	25-27	15-17	25-27	15-17	25-27
<b>CVOCs (ug/L)</b>								
1,1,1-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
1,1-DICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	17.9	5.0U	5.0U
1,1-DICHLOROETHENE		5.0U	5.0U	5.0U	5.0U	22.5	5.0U	5.0U
1,2-DICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROETHANE		10.0U	10.0U	10.0U	905	10.0U	10.0U	10.0U
CIS-1,2-DICHLOROETHYLENE		791	531	3100	5.0U	28300	9.5	14.1
TETRACHLOROETHYLENE(PCE)		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,2-DICHLOROETHENE		31.3	31.1	29.7	5.0U	122	5.0U	5.0U
TRICHLOROETHYLENE(TCE)		11.0	11.1	25100	23.4	7990	5.0U	5.0U
VINYLCHLORIDE		30.0	30.9	11.2	10.0U	117	25.6	10.0U
<b>BTEXs (ug/L)</b>								
BENZENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
ETHYLBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
TOLUENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
XYLENES,TOTAL		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U

**General Chemicals and Metals Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	HY-34-98	HY-34-98	HY-34-98	HY-35-98	HY-35-98	HY-36-98	HY-36-98
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	12/09/1998	12/09/1998	12/09/1998	12/10/1998	12/10/1998	12/09/1998	12/09/1998
	Sample ID:	67907	67908	67909	68142	68143	67905	67906
	Depth (ft):	15-17	15-17	25-27	15-17	25-27	15-17	25-27
<b>General Chemicals (ug/L)</b>								
ALKALINITY,TOTAL(ASCACO3)		280000	270000	340000	550000	400000	280000	360000
CHLORIDE(ASCL)		398000	393000	133000	187000	361000	245000	250000
NITROGEN,AMMONIA(ASN)		460	480	5430	2250	6300	5430	4520
NITROGEN,KJELDAHL,TOTAL		740	550	5430	3800	6800	5430	4520
NITROGEN,NITRATE-NITRITE		140	100	640	960	1040	300	420
PHOSPHORUS,TOTAL(ASP)		10U	10U	10U	100	10U	70	10U
PHOSPHORUS,TOTALORTHOPHOSPHATE(ASPO4)		10U	10U	10U	10U	10U	10U	10U
SULFATE(ASSO4)		81000	82000	71000	15000	426000	99000	152000
SULFIDE		50U	50U	50U	50U	50U	50U	50U
TOTALDISSOLVEDSOLIDS(RESIDUE,FILTERABLE)		1230000	1230000	708000	1070000	2730000	920000	1120000
TOTALORGANICCARBON		3300	3900	8500	38100	9800	6500	8700
<b>Metals (ug/L)</b>								
CALCIUM		176000	178000	150000	406000	956000	152000	171000
IRON		3800	2800	5500	39700	72800	9400	8200
MAGNESIUM		53800	53900	66000	92700	288000	53400	70800
POTASSIUM		5900	5600	4800	22700	20900	5400	3800
SODIUM		265000	262000	89400	202000	351000	164000	210000

**VOC Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	TP-13-98	TP-13-98	TP-16-98	W-4A-98	W-4C-98
	Sample Matrix:	WG	WG	WG	WG	WG
	Sample Date:	12/10/1998	12/11/1998	12/11/1998	12/11/1998	12/11/1998
	Sample ID:	68144	68145	68148	68146	68147
	Depth (ft):	15-17	25-27	25-27	2-4	25-27
VOCs (ug/L)						
1,1,2,2-TETRACHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
1,1,2-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
1,2-DICHLOROPROPANE		5.0U	5.0U	5.0U	5.0U	5.0U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		10.0U	10.0U	10.0U	10.0U	10.0U
BROMODICHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
BROMOFORM		5.0U	5.0U	5.0U	5.0U	5.0U
BROMOMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U
CARBONDISULFIDE		5.0U	5.0U	5.0U	5.0U	5.0U
CARBONTETRACHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROFORM		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U
CIS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U
DIBROMOCHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
METHYLENECHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U
METHYLETHYLKETONE(2-BUTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U
VINYLACETATE		10.0U	10.0U	10.0U	10.0U	10.0U



**VOC Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	TP-13-98	TP-13-98	TP-16-98	W-4A-98	W-4C-98
	Sample Matrix:	WG	WG	WG	WG	WG
	Sample Date:	12/10/1998	12/11/1998	12/11/1998	12/11/1998	12/11/1998
	Sample ID:	68144	68145	68148	68146	68147
	Depth (ft):	15-17	25-27	25-27	2-4	25-27
<b>CVOCs (ug/L)</b>						
1,1,1-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
1,1-DICHLOROETHANE		5.0U	5.0U	29.7	5.0U	5.0U
1,1-DICHLOROETHENE		84.1	97.4	11.5	5.0U	5.0U
1,2-DICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROETHANE		10.0U	10.0U	10.0U	10.0U	10.0U
CIS-1,2-DICHLOROETHYLENE		29400	55600	16400	770	5.0U
TETRACHLOROETHYLENE(PCE)		5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,2-DICHLOROETHENE		198	301	106	10.6	5.0U
TRICHLOROETHYLENE(TCE)		18400	170	27900	6.0	5.0U
VINYLCHLORIDE		344	1400	10.0U	184	10.0U
<b>BTEXs (ug/L)</b>						
BENZENE		5.0U	5.0U	5.0U	5.0U	12.7
ETHYLBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U
TOLUENE		5.0U	5.0U	5.0U	5.0U	5.0U
XYLENES,TOTAL		5.0U	5.0U	5.0U	5.0U	5.0U

**General Chemicals and Metals Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	TP-13-98	TP-13-98	TP-16-98	W-4A-98	W-4C-98
	Sample Matrix:	WG	WG	WG	WG	WG
	Sample Date:	12/10/1998	12/11/1998	12/11/1998	12/11/1998	12/11/1998
	Sample ID:	68144	68145	68148	68146	68147
	Depth (ft):	15-17	25-27	25-27	2-4	25-27
<b>General Chemicals (ug/L)</b>						
ALKALINITY,TOTAL(ASCACO3)		330000	310000	340000	300000	390000
CHLORIDE(ASCL)		305000	544000	319000	605000	122000
NITROGEN,AMMONIA(ASN)		1120	4120	4350	940	12000
NITROGEN,KJELDAHL,TOTAL		1500	4120	4350	1900	12000
NITROGEN,NITRATE-NITRITE		110	450	490	540	120
PHOSPHORUS,TOTAL(ASP)		10U	10U	10U	10U	280
PHOSPHORUS,TOTALORTHOPHOSPHATE(ASPO4)		10U	10U	10U	10U	200
SULFATE(ASSO4)		91000	100000	314000	105000	40000
SULFIDE		50U	50U	50U	50U	50U
TOTALDISSOLVEDSOLIDS(RESIDUE,FILTERABLE)		945000	1500000	1500000	1610000	673000
TOTALORGANICCARBON		6100	8500	5400	4500	17000
<b>Metals (ug/L)</b>						
CALCIUM		81500	370000	407000	294000	220000
IRON		9480	28500	9700	7910	780
MAGNESIUM		45500	60200	63200	91600	67100
POTASSIUM		7700	9300	6200	6000	6900
SODIUM		545000	458000	375000	650000	198000

**GZA GeoEnvironmental Inc.**  
**(August 1997)**

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# VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	HY-1-97	HY-1-97	HY-1-97	HY-2-97	HY-2-97	HY-2-97	HY-3-97	HY-4-97
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	HY01A-001	HY01B-002	HY01C-003	HY02A-004	HY02B-005	HY02C-006	HY03B-007	HY04A-008
Depth (ft):	6-8	15-17	25-27	6-8	15-17	25-27	15-17	6-8

## CVOCs (ug/L)

1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE								
1,1-DICHLOROETHENE	25U	25U	25U	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE	27	241	1850	25U	10400	100000	25U	25U
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	25U	25U	25U	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)	50	27	12300	2U	2U	9130	2U	2U
VINYLCHLORIDE								

# VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	HY-5-97	HY-5-97	HY-5-97	HY-6-97	HY-6-97	HY-7-97	HY-7-97
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	HY05A-009	HY05B-010	HY05C-011	HY06B-012	HY06C-061	HY07B-013	HY07C-062
Depth (ft):	6-8	15-17	25-27	15-17	25-27	15-17	25-27
CVOCs (ug/L)							
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE							
1,1-DICHLOROETHENE	25U	25U	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE	25U	25U	25U	25U	25U	25U	25U
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	25U	25U	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)	2U	2U	2U	2U	2U	2U	2U
VINYLCBLORIDE							



## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	HY-11-97	HY-11-97	HY-12-97	HY-12-97	HY-12-97	HY-13-97	HY-13-97	HY-14-97
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	HY11B-022	HY11C-023	HY12A-024	HY12B-025	HY12C-025	HY134C-028	HY13B-027	HY14A-029
Depth (ft):	15-17	25-27	6-8	15-17	25-27	25-27	15-17	6-8
<b>CVOCs (ug/L)</b>								
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE								
1,1-DICHLOROETHENE	25U	25U	25U	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE	42	25U	25U	46	573	25U	25U	25U
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	25U	25U	25U	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)	222	480	222	4	2U	2U	2U	2U
VINYLCHLORIDE								

# VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

	Location:	HY-8-97	HY-8-97	HY-8-97	HY-9-97	HY-10-97	HY-10-97	HY-10-97	HY-11-97
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
	Sample ID:	HY08A-014	HY08B-016	HY08C-017	HY09B-015	HY10A-018	HY10B-019	HY10C-020	HY11A-021
	Depth (ft):	6-8	15-17	25-27	15-17	6-8	15-17	25-27	6-8
<b>CVOCs (ug/L)</b>									
1,1,1-TRICHLOROETHANE		2U	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE									
1,1-DICHLOROETHENE		25U	25U	25U	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE		25U	25U	25U	1380	35	25U	25U	1310
TETRACHLOROETHYLENE(PCE)		2U	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE		25U	25U	25U	35	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)		2U	2U	2U	1740	2U	2U	2U	10100
VINYLCHLORIDE									

## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	HY-14-97	HY-14-97	HY-15-97	HY-15-97	HY-15-97	HY-16-97	HY-16-97	HY-16-97
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	HY14B-030	HY14C-031	HY15A-032	HY15B-033	HY15C-034	HY16A-035	HY16B-036	HY16C-037
Depth (ft):	15-17	25-27	6-8	15-17	25-27	6-8	15-17	25-27
<b>CVOCs (ug/L)</b>								
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE								
1,1-DICHLOROETHENE	25U	25U	25U	25U	45	25U	43	25U
CIS-1,2-DICHLOROETHYLENE	25U	25	25U	25U	23600	25U	22100	372
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	25U	25U	25U	110	25U	140	25U
TRICHLOROETHYLENE(TCE)	2U	2U	2U	2U	12500	34	50	7
VINYLCHLORIDE								

# VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	HY-17-97	HY-17-97	HY-17-97	HY-18-97	HY-18-97	HY-18-97	HY-19-97	HY-19-97
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	HY17A-038	HY17B-039	HY17C-040	HY18A-041	HY18B-042	HY18C-043	HY19A-044	HY19B-045
Depth (ft):	6-8	15-17	25-27	6-8	15-17	25-27	6-8	15-17
<b>CVOCs (ug/L)</b>								
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE								
1,1-DICHLOROETHENE	32	34	25U	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE	4380	5740	25U	153	4660	10800	25U	25U
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	27	35	25U	25U	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)	8350	7450	60	118	10400	100	2U	2U
VINYLCHLORIDE								

## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

<b>Location:</b>	<b>HY-19-97</b>	<b>HY-20-97</b>	<b>HY-20-97</b>	<b>HY-20-97</b>	<b>HY-21-97</b>	<b>HY-21-97</b>	<b>HY-21-97</b>
<b>Sample Matrix:</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>
<b>Sample Date:</b>	<b>07/01/1997</b>	<b>07/01/1997</b>	<b>07/01/1997</b>	<b>07/01/1997</b>	<b>07/01/1997</b>	<b>07/01/1997</b>	<b>07/01/1997</b>
<b>Sample ID:</b>	<b>HY19C-046</b>	<b>HY20A-047</b>	<b>HY20B-048</b>	<b>HY20C-049</b>	<b>HY21A-050</b>	<b>HY21B-051</b>	<b>HY21C-052</b>
<b>Depth (ft):</b>	<b>25-27</b>	<b>6-8</b>	<b>15-17</b>	<b>25-27</b>	<b>6-8</b>	<b>15-17</b>	<b>25-27</b>
<b>CVOCs (ug/L)</b>							
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE							
1,1-DICHLOROETHENE	25U	25U	25U	25U	25U	<b>218</b>	25U
CIS-1,2-DICHLOROETHYLENE	25U	25U	25U	25U	<b>898</b>	<b>21600</b>	<b>7230</b>
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	25U	25U	25U	25U	<b>205</b>	<b>65</b>
TRICHLOROETHYLENE(TCE)	2U	2U	2U	2U	2U	2U	2U
VINYLCBLORIDE							



## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	HY-22-97	HY-22-97	HY-22-97	HY-23-97	HY-23-97	HY-24-97	HY-24-97
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	HY22A-053	HY22B-054	HY22C-055	HY23A-056	HY23C-057	HY24A-058	HY24B-059
Depth (ft):	6-8	15-17	25-27	6-8	25-27	6-8	15-17
<b>CVOCs (ug/L)</b>							
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE							
1,1-DICHLOROETHENE	82	55	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE	13300	8610	525	51	50	25U	25U
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	61	49	25U	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)	9	7	7	58	2U	2U	2U
VINYLCHLORIDE							

# VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	HY-24-97	HY-UST2-97	TP-12-98	TP-12-98	TP-12-98	TP-13-98	TP-13-98
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/10/1997	07/10/1997	07/10/1997	07/10/1997	07/10/1997
Sample ID:	HY24C-060	HY-UST-C-2	TP-12A-001	TP-12B-002	TP-12C-003	TP-13A-007	TP-13B-008
Depth (ft):	25-27	25-27	6-8	15-17	25-27	6-8	15-17

## CVOCs (ug/L)

1,1,1-TRICHLOROETHANE	2U	2U	5U	5U	5U	5U	5U
1,1-DICHLOROETHANE			5U	5U	5U	2.4	5U
1,1-DICHLOROETHENE	25U	25U	5U	5U	5U	51.2	108
CIS-1,2-DICHLOROETHYLENE	25U	25U	5U	5U	5U	13000	64400
TETRACHLOROETHYLENE(PCE)	2U	2U	5U	5U	5U	5U	5U
TRANS-1,2-DICHLOROETHENE	25U	25U	5U	5U	5U	5U	280
TRICHLOROETHYLENE(TCE)	2	2U	5U	5U	5U	7250	11800
VINYLCHLORIDE			5U	5U	5U	329	660

## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	TP-13-98	TP-14-98	TP-14-98	TP-14-98	TP-15-98	TP-15-98	TP-15-98
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/10/1997	07/10/1997	07/10/1997	07/10/1997	07/10/1997	07/10/1997	07/10/1997
Sample ID:	TP-13C-009	TP-14A-004	TP-14B-005	TP-14C-006	TP-15A-013	TP-15B-014	TP-15C-016
Depth (ft):	25-27	6-8	15-17	25-27	6-8	15-17	25-27
<b>CVOCs (ug/L)</b>							
1,1,1-TRICHLOROETHANE	5U	5U	5U	5U	5U	5U	5U
1,1-DICHLOROETHANE	4.1	5U	5U	5U	5U	5U	5U
1,1-DICHLOROETHENE	78.7	5U	5U	5U	5U	5U	5U
CIS-1,2-DICHLOROETHYLENE	47800	5U	5U	5U	5U	5U	5U
TETRACHLOROETHYLENE(PCE)	5U	5U	5U	5U	5U	5U	5U
TRANS-1,2-DICHLOROETHENE	256	5U	5U	5U	5U	5U	5U
TRICHLOROETHYLENE(TCE)	549	5U	5U	5U	5U	5U	5U
VINYLCHLORIDE	634	5U	5U	5U	5U	5U	5U

## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	TP-15-98	TP-16-98	TP-16-98	TP-16-98	NONE	NONE	NONE
Sample Matrix:	WG	WG	WG	WG	WS	WS	WS
Sample Date:	07/10/1997	07/10/1997	07/10/1997	07/10/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	TP-15CA-015	TP-16A-010	TP-16B-011	TP-16C-012	SW-001	SW-002	SW-003
Depth (ft):	25-27	6-8	15-17	25-27	-	-	-

### CVOCs (ug/L)

1,1,1-TRICHLOROETHANE	5U	5U	5U	5U	2U	2U	2U
1,1-DICHLOROETHANE	5U	23.4	5U	13.9	25U	25U	25U
1,1-DICHLOROETHENE	5U	5U	5U	5.1	66	41	25U
CIS-1,2-DICHLOROETHYLENE	5U	55.8	24.2	11400	2U	2U	2U
TETRACHLOROETHYLENE(PCE)	5U	5U	5U	5U	25U	25U	25U
TRANS-1,2-DICHLOROETHENE	5U	5U	5U	5U	2U	2U	2U
TRICHLOROETHYLENE(TCE)	5U	78.7	28.4	13600			
VINYLCBLORIDE	5U	5.6	5U	5U			

# VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	NONE	NONE	W-2A-97	W-2B-97	W-2C-97	W-3-97
Sample Matrix:	WS	WS	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	SW-004	SW-005	W-2A-WAR-003	W-2B-WAR-005	W-2C-WAR-006	W-3-CON-017
Depth (ft):	-	-	2-4	15-17	25-27	25-27
<b>CVOCs (ug/L)</b>						
1,1,1-TRICHLOROETHANE	2	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE						
1,1-DICHLOROETHENE	25U	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE	25U	25U	25U	25U	25U	40
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	25U	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)	2U	2U	2U	2U	2U	2U
VINYLCHLORIDE						



## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	W-4-97	W-4A-97	W-4B-97	W-4C-97	W-6-97	W-7-97
Sample Matrix:	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	W-4-CON-018	W-4A-WAR-010	W-4B-WAR-011	W-4C-2Q4-012	W-6-CON-008	W-7-CON-009
Depth (ft):	-	2-4	15-17	25-27	25-27	25-27
<b>CVOCs (ug/L)</b>						
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE						
1,1-DICHLOROETHENE	25U	26	25U	25U	624	25U
CIS-1,2-DICHLOROETHYLENE	26	788	385	25U	33800	46
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	25U	25U	25U	212	25U
TRICHLOROETHYLENE(TCE)	2U	2U	2U	2U	2U	2U
VINYLCHLORIDE						

## VOC Results in Water

(Results from GZA GeoEnvironmental, Inc., August 1997)

Location:	W-8-97	W-9-97	W-10-97	W-11-97	W-12-97	W-12-97a	W-13-97
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
Sample Date:	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997	07/01/1997
Sample ID:	W-8-CON-004	W-9-CON-013	W-10-CON-016	W-11-CON-015	W-12-CON-014	W-12-WAR-002	W-13WAR-001
Depth (ft):	25-27	25-27	25-27	25-27	25-27	2-4	2-4
<b>CVOCs (ug/L)</b>							
1,1,1-TRICHLOROETHANE	2U	2U	2U	2U	2U	2U	2U
1,1-DICHLOROETHANE							
1,1-DICHLOROETHENE	25U	82	25U	25U	25U	25U	25U
CIS-1,2-DICHLOROETHYLENE	25U	5890	849	25U	52	25U	25U
TETRACHLOROETHYLENE(PCE)	2U	2U	2U	2U	2U	2U	2U
TRANS-1,2-DICHLOROETHENE	25U	28	25U	25U	25U	25U	25U
TRICHLOROETHYLENE(TCE)	2U	2U	563	2U	2U	2U	2U
VINYLCHLORIDE							

**First Environmental Laboratories**  
**(September 1997)**

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## VOC Results in Water

(Results from First Environmental Laboratories, 1997)

	Location:	W-6-97	HY-11-97
	Sample Matrix:	WG	WG
	Sample Date:	07/01/1997	07/02/1997
	Sample ID:	W-6-CON-008	40077
	Depth (ft):	25-27	23-23
VOCs (ug/L)			
1,1,2,2-TETRACHLOROETHANE		50.0U	5.0U
1,1,2-TRICHLOROETHANE		50.0U	5.0U
1,2-DICHLOROPROPANE		50.0U	5.0U
2-HEXANONE		100U	10.0U
ACETONE		100U	10.0U
BROMODICHLOROMETHANE		50.0U	5.0U
BROMOFORM		50.0U	5.0U
BROMOMETHANE		100U	10.0U
CARBONTETRACHLORIDE		50.0U	5.0U
CHLOROBENZENE		50.0U	5.0U
CHLOROFORM		50.0U	5.0U
CHLOROMETHANE		100U	10.0U
CIS-1,3-DICHLOROPROPENE		50.0U	5.0U
DIBROMOCHLOROMETHANE		50.0U	5.0U
METHYLENECHLORIDE		50.0U	5.0U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		100U	10.0U
STYRENE		50.0U	5.0U
TRANS-1,3-DICHLOROPROPENE		50.0U	5.0U
VINYLACETATE		100U	10.0U

## VOC Results in Water

(Results from First Environmental Laboratories, 1997)

Location:	W-6-97	HY-11-97
Sample Matrix:	WG	WG
Sample Date:	07/01/1997	07/02/1997
Sample ID:	W-6-CON-008	40077
Depth (ft):	25-27	23-23

### CVOCs (ug/L)

1,1,1-TRICHLOROETHANE	50.0U	5.0U
1,1-DICHLOROETHANE	2030	5.0U
1,1-DICHLOROETHENE	124	5.0U
1,2-DICHLOROETHANE	50.0U	5.0U
CHLOROETHANE	10.0U	10.0U
CIS-1,2-DICHLOROETHYLENE	78700	176
TETRACHLOROETHYLENE(PCE)	50.0U	5.0U
TRANS-1,2-DICHLOROETHENE	50.0U	5.0U
TRICHLOROETHYLENE(TCE)	152	747
VINYLCHLORIDE	12600	6.4

### BTEX (ug/L)

BENZENE	50.0U	5.0U
ETHYLBENZENE	50.0U	5.0U
M,P-XYLENE(SUMOFISOMERS)		
O-XYLENE(1,2-DIMETHYLBENZENE)		
TOLUENE	50.0U	5.0U
XYLENES,TOTAL	50.0U	5.0U



**Golder Associates**  
**(October 1997)**

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## VOC Results in Water

(Results from Golder Associates, October 1997)

	Location:	HY-UST1-97	HY-UST2-97
	Sample Matrix:	WG	WG
	Sample Date:	07/10/1997	07/10/1997
	Sample ID:	422995	422997
	Depth (ft):	3-8	3-8
VOCs (ug/L)			
1,1,2,2-TETRACHLOROETHANE		1.0U	1.0U
1,1,2-TRICHLOROETHANE		1.0U	1.0U
1,2-DICHLOROPROPANE		1.0U	1.0U
2-HEXANONE		20U	20U
ACETONE		20U	20U
BROMODICHLOROMETHANE		1.0U	1.0U
BROMOFORM		1.0U	1.0U
BROMOMETHANE		1.0U	1.0U
CARBONTETRACHLORIDE		1.0U	1.0U
CHLOROBENZENE		1.0U	1.0U
CHLOROFORM		1.0U	1.0U
CHLOROMETHANE		10U	10U
CIS-1,3-DICHLOROPROPENE		1.0U	1.0U
DIBROMOCHLOROMETHANE		1.0U	1.0U
METHYLENECHLORIDE		5.0U	5.0U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		20U	20U
STYRENE		1.0U	1.0U
TRANS-1,3-DICHLOROPROPENE		1.0U	1.0U

## VOC Results in Water

(Results from Golder Associates, October 1997)

	Location:	HY-UST1-97	HY-UST2-97
	Sample Matrix:	WG	WG
	Sample Date:	07/10/1997	07/10/1997
	Sample ID:	422995	422997
	Depth (ft):	3-8	3-8
<b>CVOCs (ug/L)</b>			
1,1,1-TRICHLOROETHANE		1.0U	1.0U
1,1-DICHLOROETHANE		1.0U	1.7
1,1-DICHLOROETHENE		1.0U	1.0U
1,2-DICHLOROETHANE		1.0U	1.0U
CHLOROETHANE		2.0U	15
CIS-1,2-DICHLOROETHYLENE		1.0U	6.2
TETRACHLOROETHYLENE(PCE)		1.0U	1.0U
TRANS-1,2-DICHLOROETHENE		1.0U	1.0U
TRICHLOROETHYLENE(TCE)		1.0U	1.0U
VINYLCHLORIDE		1.0U	13
<b>BTEX (ug/L)</b>			
BENZENE		1.0U	75
ETHYLBENZENE		1.0U	1.0U
M,P-XYLENE(SUMOFISOMERS)		1.0U	1.0U
O-XYLENE(1,2-DIMETHYLBENZENE)		1.0U	1.0U
TOLUENE		1.0U	2.1
XYLENES,TOTAL		1.0U	1.0U
<b>SVOCs (ug/L)</b>			
1,2-DICHLOROBENZENE		1.0U	1.0U
1,3-DICHLOROBENZENE		1.0U	1.0U
1,4-DICHLOROBENZENE		1.0U	1.0U

**PAH and Metals Results in Water**  
**(Results from Golder Associates, October 1997)**

	<b>Location:</b>	<b>HY-UST1-97</b>	<b>HY-UST2-97</b>
	<b>Sample Matrix:</b>	<b>WG</b>	<b>WG</b>
	<b>Sample Date:</b>	<b>07/10/1997</b>	<b>07/10/1997</b>
	<b>Sample ID:</b>	<b>422995</b>	<b>422997</b>
	<b>Depth (ft):</b>	<b>3-8</b>	<b>3-8</b>
<b>CPAH (ug/L)</b>			
BENZO(A)ANTHRACENE		0.13U	<b>0.98</b>
BENZO(A)PYRENE		0.23U	<b>0.79</b>
BENZO(B)FLUORANTHENE		0.18U	<b>0.62</b>
BENZO(G,H,I)PERYLENE		0.76U	0.76U
BENZO(K)FLUORANTHENE		0.17U	0.17U
CHRYSENE		1.5U	1.5U
DIBENZ(A,H)ANTHRACENE		0.3U	0.3U
INDENO(1,2,3-C,D)PYRENE		0.43U	0.43U
<b>PAH (ug/L)</b>			
ACENAPHTHENE		18U	18U
ACENAPHTHYLENE		10U	10U
ANTHRACENE		6.6U	6.6U
FLUORANTHENE		2.1U	<b>5.8</b>
FLUORENE		2.1U	<b>2.2</b>
NAPHTHALENE		10U	10U
PHENANTHRENE		6.4U	<b>6.8</b>
PYRENE		2.7U	<b>3.9</b>
<b>Metals (ug/L)</b>			
ARSENIC		<b>139</b>	<b>5U</b>

## VOC Results in Soil

(Results from Golder Associates, October 1997)

Location:	HY-UST3-97
Sample Matrix:	SO
Sample Date:	07/10/1997
Sample ID:	422999
Depth (ft):	14-16

### VOCs (ug/kg)

1,1,2,2-TETRACHLOROETHANE	5.0U
1,1,2-TRICHLOROETHANE	5.0U
1,2-DICHLOROPROPANE	5.0U
2-HEXANONE	50U
ACETONE	100U
BROMODICHLOROMETHANE	5.0U
BROMOFORM	5.0U
BROMOMETHANE	10U
CARBONTETRACHLORIDE	5.0U
CHLOROBENZENE	5.0U
CHLOROFORM	5.0U
CHLOROMETHANE	10U
CIS-1,3-DICHLOROPROPENE	5.0U
DIBROMOCHLOROMETHANE	5.0U
METHYLENECHLORIDE	5.0U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)	50U
STYRENE	5.0U
TRANS-1,3-DICHLOROPROPENE	5.0U

## VOC Results in Soil

(Results from Golder Associates, October 1997)

Location:	HY-UST3-97
Sample Matrix:	SO
Sample Date:	07/10/1997
Sample ID:	422999
Depth (ft):	14-16

### CVOCs (ug/kg)

1,1,1-TRICHLOROETHANE	5.0U
1,1-DICHLOROETHANE	5.0U
1,1-DICHLOROETHENE	5.0U
1,2-DICHLOROETHANE	5.0U
CHLOROETHANE	10U
CIS-1,2-DICHLOROETHYLENE	5.0U
TETRACHLOROETHYLENE(PCE)	5.0U
TRANS-1,2-DICHLOROETHENE	5.0U
TRICHLOROETHYLENE(TCE)	5.0U
VINYLCHLORIDE	10U

### BTEX (ug/kg)

BENZENE	5.0U
ETHYLBENZENE	5.0U
M,P-XYLENE(SUMOFISOMERS)	5.0U
O-XYLENE(1,2-DIMETHYLBENZENE)	5.0U
TOLUENE	5.0U
XYLENES,TOTAL	5.0U



## VOC Results in Soil

(Results from Golder Associates, October 1997)

Location:	HY-UST3-97
Sample Matrix:	SO
Sample Date:	07/10/1997
Sample ID:	422999
Depth (ft):	14-16

### SVOCs (ug/kg)

1,2,4-TRICHLOROBENZENE	330U
1,2-DICHLOROBENZENE	5.0U
1,3-DICHLOROBENZENE	5.0U
1,4-DICHLOROBENZENE	5.0U
2,4,6-TRICHLOROPHENOL	330U
2,4-DICHLOROPHENOL	330U
2,4-DIMETHYLPHENOL	330U
2,4-DINITROPHENOL	1600U
2,4-DINITROTOLUENE	330U
2,6-DINITROTOLUENE	330U
2-CHLORONAPHTHALENE	330U
2-CHLOROPHENOL	330U
2-NITROPHENOL	330U
3,3'-DICHLOROBENZIDINE	660U
4,6-DINITRO-2-METHYLPHENOL	1600U
4-BROMOPHENYLPHENYLETHER	330U
4-CHLORO-3-METHYLPHENOL	330U
4-CHLOROPHENYLPHENYLETHER	330U
4-NITROPHENOL	1600U
BENZIDINE	1600U
BENZYL BUTYL PHTHALATE	330U
BIS(2-CHLOROETHOXY)METHANE	330U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)	330U
BIS(2-CHLOROISOPROPYL)ETHER	330U
BIS(2-ETHYLHEXYL)PHTHALATE	330U
DIETHYL PHTHALATE	330U

## VOC Results in Soil

(Results from Golder Associates, October 1997)

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Location:	HY-UST3-97
Sample Matrix:	SO
Sample Date:	07/10/1997
Sample ID:	422999
Depth (ft):	14-16

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### SVOCs, continued (ug/kg)

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DIMETHYLPHTHALATE	330U
DI-N-BUTYLPHTHALATE	330U
DI-N-OCTYLPHTHALATE	330U
HEXACHLOROBENZENE	330U
HEXACHLOROBUTADIENE	330U
HEXACHLOROCYCLOPENTADIENE	330U
HEXACHLOROETHANE	330U
ISOPHORONE	330U
NITROBENZENE	330U
N-NITROSODIMETHYLAMINE	330U
N-NITROSODI-N-PROPYLAMINE	330U
N-NITROSODIPHENYLAMINE	330U
PENTACHLOROPHENOL	1600U
PHENOL	330U

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## PAH Results in Soil

(Results from Golder Associates, October 1997)

Location:	HY-UST3-97
Sample Matrix:	SO
Sample Date:	07/10/1997
Sample ID:	422999
Depth (ft):	14-16

### CPAHs (ug/kg)

BENZO(A)ANTHRACENE	2.6U
BENZO(A)PYRENE	4.6U
BENZO(B)FLUORANTHENE	3.6U
BENZO(G,H,I)PERYLENE	51U
BENZO(K)FLUORANTHENE	3.4U
CHRYSENE	30U
DIBENZ(A,H)ANTHRACENE	6U
INDENO(1,2,3-C,D)PYRENE	8.6U

### PAHs (ug/kg)

ACENAPHTHENE	660U
ACENAPHTHYLENE	660U
ANTHRACENE	660U
FLUORANTHENE	660U
FLUORENE	140U
NAPHTHALENE	370
PHENANTHRENE	660U
PYRENE	180U

**General Chemicals and Metals Results in Soil**  
(Results from Golder Associates, October 1997)

Location:	HY-UST3-97
Sample Matrix:	SO
Sample Date:	07/10/1997
Sample ID:	422999
Depth (ft):	14-16

**General Chemicals (%)**

TOTALSOLIDS	93.0
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**Metals (mg/L)**

ARSENIC	200U
BARIUM	464
CADMIUM	10U
CHROMIUM,TOTAL	40U
LEAD	80U
MERCURY	0.4U
SELENIUM	200U
SILVER	40U

**Ann Arbor Technical Services, Inc.**  
**(1997)**

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## VOC Soil Samples

(Results from Ann Arbor Technical Services Inc., 1994)

	Location:	SB-11-94	SB-26-94	SB-2-94	SB-29-94	SB-3-94	SB-4-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/07/1994	11/08/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
	Sample ID:	SB-11-94 0.0-2.0	SB-26-94 0.0-2.0	SB-2-94 0.0-2.0	SB-29-94 2.0-4.0	SB-3-94 2.0-4.0	SB-4-94 0.0-2.0
	Depth (ft):	0-2	0-2	0-2	2-4	2-4	0-2
VOCs (ug/kg)							
1,1,2,2-TETRACHLOROETHANE		1U	1U	1U	1U	1U	1U
1,1,2-TRICHLOROETHANE		1U	1U	1U	1U	1U	1U
1,2-DICHLOROPROPANE		1U	1U	1U	1U	1U	1U
2-HEXANONE		10U	10U	10U	10U	10U	10U
ACETONE		10U	10U	10U	10U	10U	10U
BROMODICHLOROMETHANE		1U	1U	1U	1U	1U	1U
BROMOFORM		1U	1U	1U	1U	1U	1U
BROMOMETHANE		1U	1U	1U	1U	1U	1U
CARBONTETRACHLORIDE		1U	1U	1U	1U	1U	1U
CHLOROBENZENE		1U	1U	1U	1U	1U	1U
CHLOROFORM		1U	1U	1U	1U	1U	1U
CHLOROMETHANE		1U	1U	1U	1U	1	1U
CIS-1,3-DICHLOROPROPENE		1U	1U	1U	1U	1U	1U
DIBROMOCHLOROMETHANE		1U	1U	1U	1U	1U	1U
METHYLENECHLORIDE		1U	1U	1U	1U	1U	1U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10U	10U	10U	10U	10	10U
TRANS-1,3-DICHLOROPROPENE		1U	1U	1U	1U	1U	1U



# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-11-94	SB-26-94	SB-2-94	SB-29-94	SB-3-94	SB-4-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/07/1994	11/08/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
	Sample ID:	SB-11-94 0.0-2.0	SB-26-94 0.0-2.0	SB-2-94 0.0-2.0	SB-29-94 2.0-4.0	SB-3-94 2.0-4.0	SB-4-94 0.0-2.0
	Depth (ft):	0-2	0-2	0-2	2-4	2-4	0-2
<b>CVOCs (ug/kg)</b>							
1,1,1-TRICHLOROETHANE		1U	1U	1U	1U	1U	1U
1,1-DICHLOROETHANE		1U	1U	1U	1U	1U	1U
1,1-DICHLOROETHENE		1U	1U	1U	1U	1U	1U
1,2-DICHLOROETHANE		1U	1U	1U	1U	1U	1U
CHLOROETHANE		1U	1U	1U	1U	1U	1U
CIS-1,2-DICHLOROETHYLENE		1U	1U	1U	1U	1U	1U
TETRACHLOROETHYLENE(PCE)		1U	1U	1U	1U	1U	1U
TRANS-1,2-DICHLOROETHENE		1U	1U	1U	1U	1U	1U
TRICHLOROETHYLENE(TCE)		1U	1U	1U	1U	1U	1U
VINYLCHLORIDE		1U	1U	1U	1U	1U	1U
<b>BTEXs (ug/kg)</b>							
BENZENE		1U	1U	1U	1U	1U	1U
ETHYLBENZENE		1U	1U	1U	1U	1	1U
TOLUENE		1U	1U	1U	1U	1U	1U
XYLENES,TOTAL		1U	1U	1U	1U	1U	1U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-10-94	SB-10-94	SB-11-94	SB-11-94	SB-12-94	SB-12-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
	Sample ID:	SB-10-94 0.0-2.0	SB-10-94 2.0-4.0	SB-11-94 0.0-2.0	SB-11-94 2.0-4.0	SB-12-94 0.0-2.0	SB-12-94 2.0-4.0
	Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4
<b>SVOCs (ug/kg)</b>							
1,2,4-TRICHLOROBENZENE		800U	300U	3000U	300U	300U	300U
1,2-DICHLOROBENZENE		800U	300U	3000U	300U	300U	300U
1,3-DICHLOROBENZENE		800U	300U	3000U	300U	300U	300U
1,4-DICHLOROBENZENE		800U	300U	3000U	300U	300U	300U
2,4,6-TRICHLOROPHENOL		800U	300U	3000U	300U	300U	300U
2,4-DICHLOROPHENOL		800U	300U	3000U	300U	300U	300U
2,4-DIMETHYLPHENOL		800U	300U	3000U	300U	300U	300U
2,4-DINITROPHENOL		4000U	1700U	17000U	1700U	1700U	1700U
2,4-DINITROTOLUENE		800U	300U	3000U	300U	300U	300U
2,6-DINITROTOLUENE		800U	300U	3000U	300U	300U	300U
2-CHLORONAPHTHALENE		800U	300U	3000U	300U	300U	300U
2-CHLOROPHENOL		800U	300U	3000U	300U	300U	300U
2-NITROPHENOL		800U	300U	3000U	300U	300U	300U
3,3'-DICHLOROBENZIDINE		5000U	2000U	20000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL		4000U	1700U	17000U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER		800U	300U	3000U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL		800U	300U	3000U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER		800U	300U	3000U	300U	300U	300U
4-NITROPHENOL		4000U	1700U	17000U	1700U	1700U	1700U
BENZIDINE		10000U	5000U	50000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE		800U	300U	3000U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE		800U	300U	3000U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)		800U	300U	3000U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER		800U	300U	3000U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE		800U	300U	3000U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-10-94	SB-10-94	SB-11-94	SB-11-94	SB-12-94	SB-12-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-10-94 0.0-2.0	SB-10-94 2.0-4.0	SB-11-94 0.0-2.0	SB-11-94 2.0-4.0	SB-12-94 0.0-2.0	SB-12-94 2.0-4.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4
<b>SVOCs (ug/kg)</b>						
DIETHYLPHthalate	800U	300U	3000U	300U	300U	300U
DIMETHYLPHthalate	800U	300U	3000U	300U	300U	300U
DI-N-BUTYLPHthalate	800U	300U	3000U	300U	300U	300U
DI-N-OCTYLPHthalate	800U	300U	3000U	300U	300U	300U
HEXACHLOROBENZENE	800U	300U	3000U	300U	300U	300U
HEXACHLOROBUTADIENE	800U	300U	3000U	300U	300U	300U
HEXACHLOROCYCLOPENTADIENE	800U	300U	3000U	300U	300U	300U
HEXACHLOROETHANE	800U	300U	3000U	300U	300U	300U
ISOPHORONE	800U	300U	3000U	300U	300U	300U
NITROBENZENE	800U	300U	3000U	300U	300U	300U
N-NITROSODIMETHYLAMINE			3000U			
N-NITROSODI-N-PROPYLAMINE	800U	200U	3000U	300U	300U	300U
N-NITROSODIPHENYLAMINE	800U	300U	3000U	300U	300U	300U
PENTACHLOROPHENOL	4000U	1700U	17000U	1700U	1700U	1700U
PHENOL	800U	300U	3000U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-13-94	SB-13-94	SB-14-94	SB-14-94	SB-15-94	SB-15-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
	Sample ID:	SB-13-94 0.0-2.0	SB-13-94 2.0-4.0	SB-14-94 0.0-2.0	SB-14-94 2.0-4.0	SB-15-94 0.0-2.0	SB-15-94 2.0-4.0
	Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4
<b>SVOCs (ug/kg)</b>							
1,2,4-TRICHLOROBENZENE		300U	300U	300U	300U	300U	300U
1,2-DICHLOROBENZENE		300U	300U	300U	300U	300U	300U
1,3-DICHLOROBENZENE		300U	300U	300U	300U	300U	300U
1,4-DICHLOROBENZENE		300U	300U	300U	300U	300U	300U
2,4,6-TRICHLOROPHENOL		300U	300U	300U	300U	300U	300U
2,4-DICHLOROPHENOL		300U	300U	300U	300U	300U	300U
2,4-DIMETHYLPHENOL		300U	300U	300U	300U	300U	300U
2,4-DINITROPHENOL		1700U	1700U	1700U	1700U	1700U	1700U
2,4-DINITROTOLUENE		300U	300U	300U	300U	300U	300U
2,6-DINITROTOLUENE		300U	300U	300U	300U	300U	300U
2-CHLORONAPHTHALENE		300U	300U	300U	300U	300U	300U
2-CHLOROPHENOL		300U	300U	300U	300U	300U	300U
2-NITROPHENOL		300U	300U	300U	300U	300U	300U
3,3'-DICHLOROBENZIDINE		2000U	2000U	2000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL		1700U	1700U	1700U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER		300U	300U	300U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL		300U	300U	300U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER		300U	300U	300U	300U	300U	300U
4-NITROPHENOL		1700U	1700U	1700U		1700U	1700U
BENZIDINE		5000U	5000U	5000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE		300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE		300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)		300U	300U	300U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER		300U	300U	300U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE		300U	300U	300U	300	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-13-94	SB-13-94	SB-14-94	SB-14-94	SB-15-94	SB-15-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-13-94 0.0-2.0	SB-13-94 2.0-4.0	SB-14-94 0.0-2.0	SB-14-94 2.0-4.0	SB-15-94 0.0-2.0	SB-15-94 2.0-4.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4
<b>SVOCs (ug/kg)</b>						
DIETHYLPHthalate	300U	300U	300U	300U	300U	300U
DIMETHYLPHthalate	300U	300U	300U	300U	300U	300U
DI-N-BUTYLPHthalate	300U	300U	300U	300U	300U	300U
DI-N-OCTYLPHthalate	300U	300U	300U	300U	300U	300U
HEXACHLORO BENZENE	300U	300U	300U	300U	300U	300U
HEXACHLORO BUTADIENE	300U	300U	300U	300U	300U	300U
HEXACHLORO CYCLOPENTADIENE	300U	300U	300U	300U	300U	300U
HEXACHLORO ETHANE	300U	300U	300U	300U	300U	300U
ISOPHORONE	300U	300U	300U	300U	300U	300U
NITROBENZENE	300U	300U	300U	300U	300U	300U
N-NITROSODIMETHYLAMINE						
N-NITROSODI-N-PROPYLAMINE	300U	300U	300U	300U	300U	300U
N-NITROSODIPHENYLAMINE	300U	300U	300U	300U	300U	300U
PENTACHLOROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
PHENOL	300U	300U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-16-94	SB-16-94	SB-17-94	SB-17-94	SB-18-94	SB-18-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-16-94 0.0-2.0	SB-16-94 2.0-4.0	SB-17-94 0.0-2.0	SB-17-94 2.0-4.0	SB-18-94 0.0-2.0	SB-18-94 2.0-4.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4
<b>SVOCs (ug/kg)</b>						
1,2,4-TRICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,2-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,3-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,4-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
2,4,6-TRICHLOROPHENOL	300U	300U	300U	300U	300U	300U
2,4-DICHLOROPHENOL	300U	300U	300U	300U	300U	300U
2,4-DIMETHYLPHENOL	300U	300U	300U	300U	300U	300U
2,4-DINITROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
2,4-DINITROTOLUENE	300U	300U	300U	300U	300U	300U
2,6-DINITROTOLUENE	300U	300U	300U	300U	300U	300U
2-CHLORONAPHTHALENE	300U	300U	300U	300U	300U	300U
2-CHLOROPHENOL	300U	300U	300U	300U	300U	300U
2-NITROPHENOL	300U	300U	300U	300U	300U	300U
3,3'-DICHLOROBENZIDINE	2000U	2000U	2000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER	300U	300U	300U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL	300U	300U	300U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER	300U	300U	300U	300U	300U	300U
4-NITROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
BENZIDINE	5000U	5000U	5000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER	300U	300U	300U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE	300U	300U	300U	300U	300U	300U



# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-16-94	SB-16-94	SB-17-94	SB-17-94	SB-18-94	SB-18-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-16-94 0.0-2.0	SB-16-94 2.0-4.0	SB-17-94 0.0-2.0	SB-17-94 2.0-4.0	SB-18-94 0.0-2.0	SB-18-94 2.0-4.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4
<b>SVOCs (ug/kg)</b>						
DIETHYLPHthalate	300U	300U	300U	300U	300U	300U
DIMETHYLPHthalate	300U	300U	300U	300U	300U	300U
DI-N-BUTYLPHthalate	300U	300U	300U	300U	300U	300U
DI-N-OCTYLPHthalate	300U	300U	300U	300U	300U	300U
HEXACHLOROBENZENE	300U	300U	300U	300U	300U	300U
HEXACHLOROBUTADIENE	300U	300U	300U	300U	300U	300U
HEXACHLOROCYCLOPENTADIENE	300U	300U	300U	300U	300U	300U
HEXACHLOROETHANE	300U	300U	300U	300U	300U	300U
ISOPHORONE	300U	300U	300U	300U	300U	300U
NITROBENZENE	300U	300U	300U	300U	300U	300U
N-NITROSODIMETHYLAMINE						
N-NITROSODI-N-PROPYLAMINE	300U	300U	300U	300U	300U	300U
N-NITROSODIPHENYLAMINE	300U	300U	300U	300U	300U	300U
PENTACHLOROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
PHENOL	300U	300U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-19-94	SB-19-94	SB-20-94	SB-20-94	SB-20-94	SB-21-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-19-94 0.0-2.0	SB-19-94 2.0-4.0	SB-20-94 0.0-2.0	SB-20-94 2.0-4.0	SB-20-94 4.0-6.0	SB-21-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	2-4	4-6	0-2
SVOCs (ug/kg)						
1,2,4-TRICHLOROBENZENE	300U	2000U	300U	300U	300U	300U
1,2-DICHLOROBENZENE	300U	2000U	300U	300U	300U	300U
1,3-DICHLOROBENZENE	300U	2000U	300U	300U	300U	300U
1,4-DICHLOROBENZENE	300U	2000U	300U	300U	300U	300U
2,4,6-TRICHLOROPHENOL	300U	2000U	300U	300U	300U	300U
2,4-DICHLOROPHENOL	300U	2000U	300U	300U	300U	300U
2,4-DIMETHYLPHENOL	300U	2000U	300U	300U	300U	300U
2,4-DINITROPHENOL	1700U	8000U	1700U	1700U	1700U	1700U
2,4-DINITROTOLUENE	300U	2000U	300U	300U	300U	300U
2,6-DINITROTOLUENE	300U	2000U	300U	300U	300U	300U
2-CHLORONAPHTHALENE	300U	2000U	300U	300U	300U	300U
2-CHLOROPHENOL	300U	2000U	300U	300U	300U	300U
2-NITROPHENOL	300U	2000U	300U	300U	300U	300U
3,3'-DICHLOROBENZIDINE	2000U	10000U	2000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL	1700U	8000U	1700U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER	300U	2000U	300U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL	300U	2000U	300U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER	300U	2000U		300U	300U	300U
4-NITROPHENOL	1700U	8000U	1700U	1700U	1700U	1700U
BENZIDINE	5000U	25000U	5000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE	300U	2000U	300U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE	300U	2000U	300U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)	300U	2000U	300U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER	300U	2000U	300U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE	300U	2000U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-19-94	SB-19-94	SB-20-94	SB-20-94	SB-20-94	SB-21-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
	Sample ID:	SB-19-94 0.0-2.0	SB-19-94 2.0-4.0	SB-20-94 0.0-2.0	SB-20-94 2.0-4.0	SB-20-94 4.0-6.0	SB-21-94 0.0-2.0
	Depth (ft):	0-2	2-4	0-2	2-4	4-6	0-2
<b>SVOCs (ug/kg)</b>							
DIETHYLPHthalate		300U	2000U	300U	300U	300U	300U
DIMETHYLPHthalate		300U	2000U	300U	300U	300U	300U
DI-N-BUTYLPHthalate		300U	2000U	300U	300U	300U	300U
DI-N-OCTYLPHthalate		300U	2000U	300U	300U	300U	300U
HEXACHLOROBENZENE		300U	2000U	300U	300U	300U	300U
HEXACHLOROBUTADIENE		300U	2000U	300U	300U	300U	300U
HEXACHLOROCYCLOPENTADIENE		300U	2000U	300U	300U	300U	300U
HEXACHLOROETHANE		300U	2000U	300U	300U	300U	300U
ISOPHORONE		300U	2000U	300U	300U	300U	300U
NITROBENZENE		300U	2000U	300U	300U	300U	300U
N-NITROSODIMETHYLAMINE							
N-NITROSODI-N-PROPYLAMINE		300U	2000U	300U	300U	300U	300U
N-NITROSODIPHENYLAMINE		300U	2000U	300U	300U	300U	300U
PENTACHLOROPHENOL		1700U	8000U	1700U	1700U	1700U	1700U
PHENOL		300U	2000U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-21-94	SB-22-94	SB-22-94	SB-23-94	SB-23-94	SB-24-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-21-94 2.0-4.0	SB-22-94 0.0-2.0	SB-22-94 2.0-4.0	SB-23-94 0.0-2.0	SB-23-94 2.0-4.0	SB-24-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2
SVOCs (ug/kg)						
1,2,4-TRICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,2-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,3-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,4-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
2,4,6-TRICHLOROPHENOL	300U	300U	300U	300U	300U	300U
2,4-DICHLOROPHENOL	300U	300U	300U	300U	300U	300U
2,4-DIMETHYLPHENOL	300U	300U	300U	300U	300U	300U
2,4-DINITROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
2,4-DINITROTOLUENE	300U	300U	300U	300U	300U	300U
2,6-DINITROTOLUENE	300U	300U	300U	300U	300U	300U
2-CHLORONAPHTHALENE	300U	300U	300U	300U	300U	300U
2-CHLOROPHENOL	300U	300U	300U	300U	300U	300U
2-NITROPHENOL	300U	300U	300U	300U	300U	300U
3,3'-DICHLOROBENZIDINE	2000U	2000U	2000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER	300U	300U	300U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL	300U	300U	300U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER	300U	300U	300U	300U	300U	300U
4-NITROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
BENZIDINE	5000U	5000U	5000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER	300U	300U	300U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE	300U	300U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-21-94	SB-22-94	SB-22-94	SB-23-94	SB-23-94	SB-24-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-21-94 2.0-4.0	SB-22-94 0.0-2.0	SB-22-94 2.0-4.0	SB-23-94 0.0-2.0	SB-23-94 2.0-4.0	SB-24-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2
SVOCs (ug/kg)						
DIETHYLPHthalate	300U	300U	300U	300U	300U	300U
DIMETHYLPHthalate	300U	300U	300U	300U	300U	300U
DI-N-BUTYLPHthalate	300U	300U	300U	300U	300U	300U
DI-N-OCTYLPHthalate	300U	300U	300U	300U	300U	300U
HEXACHLORO BENZENE	300U	300U	300U	300U	300U	300U
HEXACHLOROBUTADIENE	300U	300U	300U	300U	300U	300U
HEXACHLOROCYCLOPENTADIENE	300U	300U	300U	300U	300U	300U
HEXACHLOROETHANE	300U	300U	300U	300U	300U	300U
ISOPHORONE	300U	300U	300U	300U	300U	300U
NITROBENZENE	300U	300U	300U	300U	300U	300U
N-NITROSODIMETHYLAMINE						
N-NITROSODI-N-PROPYLAMINE	300U	300U	300U	300U	300U	300U
N-NITROSODIPHENYLAMINE	300U	300U	300U	300U	300U	300U
PENTACHLOROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
PHENOL	300U	300U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-24-94	SB-25-94	SB-25-94	SB-26-94	SB-26-94	SB-27-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/08/1994	11/07/1994
Sample ID:	SB-24-94 2.0-4.0	SB-25-94 0.0-2.0	SB-25-94 2.0-4.0	SB-26-94 2.0-4.0	SB-26-94 0.0-2.0	SB-27-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	2-4	0-2	0-2

## SVOCs (ug/kg)

1,2,4-TRICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,2-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,3-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
1,4-DICHLOROBENZENE	300U	300U	300U	300U	300U	300U
2,4,6-TRICHLOROPHENOL	300U	300U	300U	300U	300U	300U
2,4-DICHLOROPHENOL	300U	300U	300U	300U	300U	300U
2,4-DIMETHYLPHENOL	300U	300U	300U	300U	300U	300U
2,4-DINITROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
2,4-DINITROTOLUENE	300U	300U	300U	300U	300U	300U
2,6-DINITROTOLUENE	300U	300U	300U	300U	300U	300U
2-CHLORONAPHTHALENE	300U	300U	300U	300U	300U	300U
2-CHLOROPHENOL	300U	300U	300U	300U	300U	300U
2-NITROPHENOL	300U	300U	300U	300U	300U	300U
3,3'-DICHLOROBENZIDINE	2000U	2000U	2000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER	300U	300U	300U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL	300U	300U	300U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER	300U	300U	300U	300U	300U	300U
4-NITROPHENOL	1700U	1700U	1700U	1700U	1700U	1700U
BENZIDINE	5000U	5000U	5000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)	300U	300U	300U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER	300U	300U	300U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE	300U	300U	300U	300U	300U	300U



# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-24-94	SB-25-94	SB-25-94	SB-26-94	SB-26-94	SB-27-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/08/1994	11/07/1994
	Sample ID:	SB-24-94 2.0-4.0	SB-25-94 0.0-2.0	SB-25-94 2.0-4.0	SB-26-94 2.0-4.0	SB-26-94 0.0-2.0	SB-27-94 0.0-2.0
	Depth (ft):	2-4	0-2	2-4	2-4	0-2	0-2
SVOCs (ug/kg)							
DIETHYLPHthalate		300U	300U	300U	300U	300U	300U
DIMETHYLPHthalate		300U	300U	300U	300U	300U	300U
DI-N-BUTYLPHthalate		300U	300U	300U	300U	300	300U
DI-N-OCTYLPHthalate		300U	300U	300U	300U	300U	300U
HEXACHLOROBENZENE		300U	300U	300U	300U	300U	300U
HEXACHLOROBUTADIENE		300U	300U	300U	300U	300U	300U
HEXACHLOROCYCLOPENTADIENE		300U	300U	300U	300U	300U	300U
HEXACHLOROETHANE		300U	300U	300U	300U	300U	300U
ISOPHORONE		300U	300U	300U	300U	300U	300U
NITROBENZENE		300U	300U	300U	300U	300U	300U
N-NITROSODIMETHYLAMINE						300U	
N-NITROSODI-N-PROPYLAMINE		300U	300U	300U	300U	300U	300U
N-NITROSODIPHENYLAMINE		300U	300U	300U	300U	300U	300U
PENTACHLOROPHENOL		1700U	1700U	1700U	1700U	1700U	1700U
PHENOL		300U	300U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-27-94	SB-28-94	SB-28-94	SB-29-94	SB-29-94	SB-30-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/08/1994
Sample ID:	SB-27-94 2.0-4.0	SB-28-94 0.0-2.0	SB-28-94 2.0-4.0	SB-29-94 0.0-2.0	SB-29-94 2.0-4.0	SB-30-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2
SVOCs (ug/kg)						
1,2,4-TRICHLOROBENZENE	300U	300U	300U	300U	3000U	300U
1,2-DICHLOROBENZENE	300U	300U	300U	300U	3000U	300U
1,3-DICHLOROBENZENE	300U	300U	300U	300U	3000U	300U
1,4-DICHLOROBENZENE	300U	300U	300U	300U	3000U	300U
2,4,6-TRICHLOROPHENOL	300U	300U	300U	300U	3000U	300U
2,4-DICHLOROPHENOL	300U	300U	300U	300U	3000U	300U
2,4-DIMETHYLPHENOL	300U	300U	300U	300U	3000U	300U
2,4-DINITROPHENOL	1700U	1700U	1700U	1700U	17000U	1700U
2,4-DINITROTOLUENE	300U	300U	300U	300U	3000U	300U
2,6-DINITROTOLUENE	300U	300U	300U	300U	3000U	300U
2-CHLORONAPHTHALENE	300U	300U	300U	300U	3000U	300U
2-CHLOROPHENOL	300U	300U	300U	300U	3000U	300U
2-NITROPHENOL	300U	300U	300U	300U	3000U	300U
3,3'-DICHLOROBENZIDINE	2000U	2000U	2000U	2000U	20000U	2000U
4,6-DINITRO-2-METHYLPHENOL	1700U	1700U	1700U	1700U	17000U	1700U
4-BROMOPHENYLPHENYLETHER	300U	300U	300U	300U	3000U	300U
4-CHLORO-3-METHYLPHENOL	300U	300U	300U	300U	3000U	300U
4-CHLOROPHENYLPHENYLETHER	300U	300U	300U	300U	3000U	300U
4-NITROPHENOL	1700U	1700U	1700U	1700U	17000U	1700U
BENZIDINE	5000U	5000U	5000U	5000U	50000U	5000U
BENZYL BUTYL PHTHALATE	300U	300U	300U	300U	3000U	300U
BIS(2-CHLOROETHOXY)METHANE	300U	300U	300U	300U	3000U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)	300U	300U	300U	300U	3000U	300U
BIS(2-CHLOROISOPROPYL)ETHER	300U	300U	300U	300U	3000U	300U
BIS(2-ETHYLHEXYL)PHTHALATE	300U	300U	300U	300U	3000U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-27-94	SB-28-94	SB-28-94	SB-29-94	SB-29-94	SB-30-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/08/1994
Sample ID:	SB-27-94 2.0-4.0	SB-28-94 0.0-2.0	SB-28-94 2.0-4.0	SB-29-94 0.0-2.0	SB-29-94 2.0-4.0	SB-30-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2
<b>SVOCs (ug/kg)</b>						
DIETHYLPHthalate	300U	300U	300U	300U	3000U	300U
DIMETHYLPHthalate	300U	300U	300U	300U	3000U	300U
DI-N-BUTYLPHthalate	300U	300U	300U	300U	3000U	300U
DI-N-OCTYLPHthalate	300U	300U	300U	300U	3000U	300U
HEXACHLOROBENZENE	300U	300U	300U	300U	3000U	300U
HEXACHLOROBUTADIENE	300U	300U	300U	300U	3000U	300U
HEXACHLOROCYCLOPENTADIENE	300U	300U	300U	300U	3000U	300U
HEXACHLOROETHANE	300U	300U	300U	300U	3000U	300U
ISOPHORONE	300U	300U	300U	300U	3000U	300U
NITROBENZENE	300U	300U	300U	300U	3000U	300U
N-NITROSODIMETHYLAMINE					3000U	
N-NITROSODI-N-PROPYLAMINE	300U	300U	300U	300U	3000U	300U
N-NITROSODIPHENYLAMINE	300U	300U	300U	300U	3000U	300U
PENTACHLOROPHENOL	1700U	1700U	1700U	1700U	17000U	1700U
PHENOL	300U	300U	300U	300U	3000U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-30-94	SB-31-94	SB-31-94	SB-32-94	SB-32-94	SB-33-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-30-94 2.0-4.0	SB-31-94 0.0-2.0	SB-31-94 2.0-4.0	SB-32-94 0.0-2.0	SB-32-94 2.0-4.0	SB-33-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2
SVOCs (ug/kg)						
1,2,4-TRICHLOROBENZENE	300U	300U	300U	800U	300U	300U
1,2-DICHLOROBENZENE	300U	300U	300U	800U	300U	300U
1,3-DICHLOROBENZENE	300U	300U	300U	800U	300U	300U
1,4-DICHLOROBENZENE	300U	300U	300U	800U	300U	300U
2,4,6-TRICHLOROPHENOL	300U	300U	300U	800U	300U	300U
2,4-DICHLOROPHENOL	300U	300U	300U	800U	300U	300U
2,4-DIMETHYLPHENOL	300U	300U	300U	800U	300U	300U
2,4-DINITROPHENOL	1700U	1700U	1700U	4000U	1700U	1700U
2,4-DINITROTOLUENE	300U	300U	300U	800U	300U	300U
2,6-DINITROTOLUENE	300U	300U	300U	800U	300U	300U
2-CHLORONAPHTHALENE	300U	300U	300U	800U	300U	300U
2-CHLOROPHENOL	300U	300U	300U	800U	300U	300U
2-NITROPHENOL	300U	300U	300U	800U	300U	300U
3,3'-DICHLOROBENZIDINE	2000U	2000U	2000U	5000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL	1700U	1700U	1700U	4000U	1700U	1700U
4-BROMOPHENYLPHENYLETHER	300U	300U	300U	800U	300U	300U
4-CHLORO-3-METHYLPHENOL	300U	300U	300U	800U	300U	300U
4-CHLOROPHENYLPHENYLETHER	300U	300U	300U	800U	300U	300U
4-NITROPHENOL	1700U	1700U	1700U	4000U	1700U	1700U
BENZIDINE	5000U	5000U	300U	10000U	5000U	5000U
BENZYL BUTYL PHTHALATE	300U	300U	300U	800U	300U	300U
BIS(2-CHLOROETHOXY)METHANE	300U	300U	300U	800U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)	300U	300U	300U	800U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER	300U	300U	300U	800U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE	300U	300U	300U	800U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-30-94	SB-31-94	SB-31-94	SB-32-94	SB-32-94	SB-33-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-30-94 2.0-4.0	SB-31-94 0.0-2.0	SB-31-94 2.0-4.0	SB-32-94 0.0-2.0	SB-32-94 2.0-4.0	SB-33-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2
<b>SVOCs (ug/kg)</b>						
DIETHYLPHthalate	300U	300U	300U	800U	300U	300U
DIMETHYLPHthalate	300U	300U	300U	800U	300U	300U
DI-N-BUTYLPHthalate	300U	300U	300U	800U	300U	300U
DI-N-OCTYLPHthalate	300U	300U	300U	800U	300U	300U
HEXACHLORO Benzene	300U	300U	300U	800U	300U	300U
HEXACHLORO Butadiene	300U	300U	300U	800U	300U	300U
HEXACHLORO Cyclopentadiene	300U	300U	300U	800U	300U	300U
HEXACHLORO Ethane	300U	300U	300U	800U	300U	300U
ISOPHORONE	300U	300U	300U	800U	300U	300U
NITRO Benzene	300U	300U	300U	800U	300U	300U
N-NITROSODIMETHYLAMINE						
N-NITROSODI-N-PROPYLAMINE	300U	300U	300U	800U	300U	300U
N-NITROSODIPHENYLAMINE	300U	300U	300U	800U	300U	300U
PENTACHLOROPHENOL	1700U	1700U	1700U	4000U	1700U	1700U
PHENOL	300U	300U	300U	800U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-33-94	SB-34-94	SB-34-94	SB-34-94	SB-34-94	SB-34-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
	Sample ID:	SB-33-94 2.0-4.0	SB-34-94 20-22	SB-34-94 22-24	SB-34-94 24-26	SB-34-94 26-28	SB-34-94 28-30
	Depth (ft):	2-4	20-22	22-24	24-26	26-28	28-30
<b>SVOCs (ug/kg)</b>							
1,2,4-TRICHLOROBENZENE		300U	300U	300U	300U	300U	300U
1,2-DICHLOROBENZENE		300U	300U	300U	300U	300U	300U
1,3-DICHLOROBENZENE		300U	300U	300U	300U	300U	300U
1,4-DICHLOROBENZENE		300U	300U	300U	300U	300U	300U
2,4,6-TRICHLOROPHENOL		300U	300U	300U	300U	300U	300U
2,4-DICHLOROPHENOL		300U	300U	300U	300U	300U	300U
2,4-DIMETHYLPHENOL		300U	300U	300U	300U	300U	300U
2,4-DINITROPHENOL		1700U	1700U	1700U	1700U	1700U	1700U
2,4-DINITROTOLUENE		300U	300U	300U	300U	300U	300U
2,6-DINITROTOLUENE		300U	300U	300U	300U	300U	300U
2-CHLORONAPHTHALENE		300U	300U	300U	300U	300U	300U
2-CHLOROPHENOL		300U	300U	300U	300U	300U	300U
2-NITROPHENOL		300U	300U	300U	300U	300U	300U
3,3'-DICHLOROBENZIDINE		2000U	2000U	2000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL		1700U	1700U	1700U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER		300U	300U	300U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL		300U	300U	300U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER		300U	300U	300U	300U	300U	300U
4-NITROPHENOL		1700U	1700U	1700U	1700U	1700U	1700U
BENZIDINE		5000U	5000U	5000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE		300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE		300U	300U	300U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)		300U	300U	300U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER		300U	300U	300U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE		300U	300U	6400	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-33-94	SB-34-94	SB-34-94	SB-34-94	SB-34-94	SB-34-94
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
	Sample ID:	SB-33-94 2.0-4.0	SB-34-94 20-22	SB-34-94 22-24	SB-34-94 24-26	SB-34-94 26-28	SB-34-94 28-30
	Depth (ft):	2-4	20-22	22-24	24-26	26-28	28-30
<b>SVOCs (ug/kg)</b>							
DIETHYLPHthalate		300U	300U	300U	300U	300U	300U
DIMETHYLPHthalate		300U	300U	300U	300U	300U	300U
DI-N-BUTYLPHthalate		300U	300U	300U	300U	300U	300U
DI-N-OCTYLPHthalate		300U	300U	300U	300U	300U	300U
HEXACHLOROBENZENE		300U	300U	300U	300U	300U	300U
HEXACHLOROBUTADIENE		300U	300U	300U	300U	300U	300U
HEXACHLOROCYCLOPENTADIENE		300U	300U	300U	300U	300U	300U
HEXACHLOROETHANE		300U	300U	300U	300U	300U	300U
ISOPHORONE		300U	300U	300U	300U	300U	300U
NITROBENZENE		300U	300U	300U	300U	300U	300U
N-NITROSODIMETHYLAMINE							
N-NITROSODI-N-PROPYLAMINE		300U	300U	300U	300U	300U	300U
N-NITROSODIPHENYLAMINE		300U	300U	300U	300U	300U	300U
PENTACHLOROPHENOL		1700U	1700U	1700U	1700U	1700U	1700U
PHENOL		300U	300U	300U	300U	300U	300U



# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-34-94	SB-35-94	SB-35-94	SB-35-94	SB-35-94
	Sample Matrix:	SO	SO	SO	SO	SO
	Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
	Sample ID:	SB-34-94 30-32	SB-35-94 25-27	SB-35-94 27-29	SB-35-94 29-31	SB-35-94 31-33
	Depth (ft):	30-32	25-27	27-29	29-31	31-33
SVOCs (ug/kg)						
1,2,4-TRICHLOROBENZENE		300U	300U	300U	300U	300U
1,2-DICHLOROBENZENE		300U	300U	300U	300U	300U
1,3-DICHLOROBENZENE		300U	300U	300U	300U	300U
1,4-DICHLOROBENZENE		300U	300U	300U	300U	300U
2,4,6-TRICHLOROPHENOL		300U	300U	300U	300U	300U
2,4-DICHLOROPHENOL		300U	300U	300U	300U	300U
2,4-DIMETHYLPHENOL		300U	300U	300U	300U	300U
2,4-DINITROPHENOL		1700U	1700U	1700U	1700U	1700U
2,4-DINITROTOLUENE		300U	300U	300U	300U	300U
2,6-DINITROTOLUENE		300U	300U	300U	300U	300U
2-CHLORONAPHTHALENE		300U	300U	300U	300U	300U
2-CHLOROPHENOL		300U	300U	300U	300U	300U
2-NITROPHENOL		300U	300U	300U	300U	300U
3,3'-DICHLOROBENZIDINE		2000U	2000U	2000U	2000U	2000U
4,6-DINITRO-2-METHYLPHENOL		1700U	1700U	1700U	1700U	1700U
4-BROMOPHENYLPHENYLETHER		300U	300U	300U	300U	300U
4-CHLORO-3-METHYLPHENOL		300U	300U	300U	300U	300U
4-CHLOROPHENYLPHENYLETHER		300U	300U	300U	300U	300U
4-NITROPHENOL		1700U	1700U	1700U	1700U	1700U
BENZIDINE		5000U	5000U	5000U	5000U	5000U
BENZYL BUTYL PHTHALATE		300U	300U	300U	300U	300U
BIS(2-CHLOROETHOXY)METHANE		300U	300U	300U	300U	300U
BIS(2-CHLOROETHYL)ETHER(2-CHLOROETHYLETHER)		300U	300U	300U	300U	300U
BIS(2-CHLOROISOPROPYL)ETHER		300U	300U	300U	300U	300U
BIS(2-ETHYLHEXYL)PHTHALATE		300U	300U	300U	300U	300U

# VOC Soil Samples

(Results from Ann Arbor Technical Services, 1994)

	Location:	SB-34-94	SB-35-94	SB-35-94	SB-35-94	SB-35-94
	Sample Matrix:	SO	SO	SO	SO	SO
	Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
	Sample ID:	SB-34-94 30-32	SB-35-94 25-27	SB-35-94 27-29	SB-35-94 29-31	SB-35-94 31-33
	Depth (ft):	30-32	25-27	27-29	29-31	31-33
SVOCs (ug/kg)						
DIETHYLPHthalate		300U	300U	300U	300U	300U
DIMETHYLPHthalate		300U	300U	300U	300U	300U
DI-N-BUTYLPHthalate		300U	300U	300U	300U	300U
DI-N-OCTYLPHthalate		300U	300U	300U	300U	300U
HEXACHLOROBENZENE		300U	300U	300U	300U	300U
HEXACHLOROBUTADIENE		300U	300U	300U	300U	300U
HEXACHLOROCYCLOPENTADIENE		300U	300U	300U	300U	300U
HEXACHLOROETHANE		300U	300U	300U	300U	300U
ISOPHORONE		300U	300U	300U	300U	300U
NITROBENZENE		300U	300U	300U	300U	300U
N-NITROSODIMETHYLAMINE						
N-NITROSODI-N-PROPYLAMINE		300U	300U	300U	300U	300U
N-NITROSODIPHENYLAMINE		300U	300U	300U	300U	300U
PENTACHLOROPHENOL		1700U	1700U	1700U	1700U	1700U
PHENOL		300U	300U	300U	300U	300U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-1-94	SB-1-94	SB-2-94	SB-2-94	SB-3-94	SB-3-94	SB-4-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-1-94 0.0-2.0	SB-1-94 2.0-4.0	SB-2-94 0.0-2.0	SB-2-94 2.0-4.0	SB-3-94 0.0-2.0	SB-3-94 2.0-4.0	SB-4-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4	0-2
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	600U	600U	3000U	600U	3000U	300U	3000U
BENZO(A)PYRENE	300U	300U	3000U	300U	2000U	300U	3000U
BENZO(B)FLUORANTHENE	600U	600U	3000U	600U	3000U	300U	3000U
BENZO(G,H,I)PERYLENE	300U	300U	3000U	300U	2000U	300U	3000U
BENZO(K)FLUORANTHENE	600U	600U	3000U	600U	3000U	300U	3000U
CHRYSENE	600U	600U	3000U	600U	3000U	300U	3000U
DIBENZ(A,H)ANTHRACENE	300U	300U	3000U	300U	2000U	300U	3000U
INDENO(1,2,3-C,D)PYRENE	300U	300U	3000U	300U	2000U	300U	3000U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	300U	300U	3000U	300U	2000U	300U	3000U
ACENAPHTHYLENE	300U	300U	3000U	300U	2000U	300U	3000U
ANTHRACENE	300U	300U	3000U	300U	2000U	300U	3000U
FLUORANTHENE	300U	300U	3000U	300U	2000U	300U	3000U
FLUORENE	300U	300U	3000U	300U	2000U	300U	3000U
NAPHTHALENE	300U	300U	3000U	300U	2000U	300U	3000U
PHENANTHRENE	300U	300U	7000	300U	2000U	300U	3000U
PYRENE	300U	300U	3000U	300U	2000U	300U	3000U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-4-94	SB-5-94	SB-5-94	SB-6-94	SB-6-94	SB-7-94	SB-7-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-4-94 2.0-4.0	SB-5-94 0.0-2.0	SB-5-94 2.5-4.5	SB-6-94 0.0-2.0	SB-6-94 2.0-4.0	SB-7-94 0.0-2.0	SB-7-94 2.0-4.0
Depth (ft):	2-4	0-2	2.5-4.5	0-2	2-4	0-2	2-4
CPAHs (ug/kg)							
BENZO(A)ANTHRACENE	3000U	600U	3000U	600U	3000U	600U	600U
BENZO(A)PYRENE	2000U	300U	2000U	300U	2000U	300U	300U
BENZO(B)FLUORANTHENE	3000U	600U	2000U	600U	3000U	600U	600U
BENZO(G,H,I)PERYLENE	2000U	300U	2000U	300U	2000U	300U	300U
BENZO(K)FLUORANTHENE	3000U	600U	2000U	600U	3000U	600U	600U
CHRYSENE	3000U	600U	3000U	600U	3000U	600U	600U
DIBENZ(A,H)ANTHRACENE	2000U	300U	2000U	300U	2000U	300U	300U
INDENO(1,2,3-C,D)PYRENE	2000U	300U	2000U	300U	2000U	300U	300U
PAHs (ug/kg)							
ACENAPHTHENE	2000U	300U	2000U	300U	2000U	300U	300U
ACENAPHTHYLENE	2000U	300U	2000U	300U	2000U	300U	300U
ANTHRACENE	2000U	300U	2000U	300U	2000U	300U	300U
FLUORANTHENE	2000U	300U	2000U	300U	2000U	300U	300U
FLUORENE	2000U	300U	2000U	300U	2000U	300U	300U
NAPHTHALENE	2000U	300U	2000U	300U	2000U	300U	300U
PHENANTHRENE	2000U	300U	2000U	300U	2000U	300U	300U
PYRENE	2000U	300U	2000U	300U	2000U	300U	300U

## PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-8-94	SB-8-94	SB-9-94	SB-9-94	SB-10-94	SB-10-94	SB-11-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-8-94 0.0-2.0	SB-8-94 2.0-4.0	SB-9-94 0.0-2.0	SB-9-94 2.0-4.0	SB-10-94 0.0-2.0	SB-10-94 2.0-4.0	SB-11-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	4-4	0-2	2-4	0-2
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	14000	600U	600U	600U	2000U	600U	3000U
BENZO(A)PYRENE	11000	300U	300U	300U	800U	300U	15000
BENZO(B)FLUORANTHENE	12000	600U	600U	600U	2000U	600U	8000
BENZO(G,H,I)PERYLENE	6000	300U	300U	300U	800U	300U	6000
BENZO(K)FLUORANTHENE	12000	600U	600U	600U	2000U	600U	8000
CHRYSENE	14000	600U	600U	600U	2000U	600U	3000U
DIBENZ(A,H)ANTHRACENE	3000	300U	300U	300U	800U	300U	4000
INDENO(1,2,3-C,D)PYRENE	2000	300U	300U	300U	800U	300U	8000
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	2000U	300U	300U	300U	800U	300U	3000U
ACENAPHTHYLENE	2000U	300U	300U	300U	800U	300U	3000U
ANTHRACENE	2000U	300U	300U	300U	800U	300U	3000U
FLUORANTHENE	17000	300U	300U	300U	800U	300U	3000U
FLUORENE	2000U	300U	300U	300U	800U	300U	3000U
NAPHTHALENE	2000U	300U	300U	300U	800U	300U	3000U
PHENANTHRENE	12000	300U	300U	300U	800U	300U	7000
PYRENE	15000	300U	300U	300U	800U	300U	3000U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-11-94	SB-12-94	SB-12-94	SB-13-94	SB-13-94	SB-14-94	SB-14-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-11-94 2.0-4.0	SB-12-94 0.0-2.0	SB-12-94 2.0-4.0	SB-13-94 0.0-2.0	SB-13-94 2.0-4.0	SB-14-94 0.0-2.0	SB-14-94 2.0-4.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2	2-4
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	600U	600U	600U	600U	600U	600U	600U
BENZO(A)PYRENE	300U	300U	300U	300U	300U	300U	300U
BENZO(B)FLUORANTHENE	600U	600U	600U	600U	600U	600U	600U
BENZO(G,H,I)PERYLENE	600U	300U	300U	300U	300U	300U	300U
BENZO(K)FLUORANTHENE	600U	600U	600U	600U	600U	600U	600U
CHRYSENE	600U	600U	600U	600U	600U	600U	600U
DIBENZ(A,H)ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	300U	300U	300U	300U	300U	300U	300U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	300U	300U	300U	300U	300U	300U	300U
ACENAPHTHYLENE	300U	300U	300U	300U	300U	300U	300U
ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
FLUORANTHENE	300U	300U	300U	300U	300U	300U	300U
FLUORENE	300U	300U	300U	300U	300U	300U	300U
NAPHTHALENE	300U	300U	300U	300U	300U	300U	300U
PHENANTHRENE	300U	300U	300U	300U	300U	300U	300U
PYRENE	300U	300U	300U	300U	300U	300U	300U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-15-94	SB-15-94	SB-16-94	SB-16-94	SB-17-94	SB-17-94	SB-18-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-15-94 0.0-2.0	SB-15-94 2.0-4.0	SB-16-94 0.0-2.0	SB-16-94 2.0-4.0	SB-17-94 0.0-2.0	SB-17-94 2.0-4.0	SB-18-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4	0-2
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	600U	600U	600U	600U	600	600U	600U
BENZO(A)PYRENE	300	300U	300	300U	600	300U	300U
BENZO(B)FLUORANTHENE	600U	600U	600U	600U	800	600U	600U
BENZO(G,H,I)PERYLENE	300U	300U	300U	300U	300	300U	300U
BENZO(K)FLUORANTHENE	600U	600U	600U	600U	800	600U	600U
CHRYSENE	600U	600U	600U	600U	600	600U	600U
DIBENZ(A,H)ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	300U	300U	300U	300U	300U	300U	300U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	300U	300U	300U	300U	300U	300U	300U
ACENAPHTHYLENE	300U	300U	300U	300U	300U	300U	300U
ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
FLUORANTHENE	300U	300U	300U	300U	900	300U	300U
FLUORENE	300U	300U	300U	300U	300U	300U	300U
NAPHTHALENE	300U	300U	300U	300U	300U	300U	300U
PHENANTHRENE	300U	300U	300U	300U	600	300U	300U
PYRENE	300U	300U	300U	300U	900	300U	300U



# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-18-94	SB-19-94	SB-19-94	SB-20-94	SB-20-94	SB-20-94	SB-21-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-18-94 2.0-4.0	SB-19-94 0.0-2.0	SB-19-94 2.0-4.0	SB-20-94 0.0-2.0	SB-20-94 2.0-4.0	SB-20-94 4.0-6.0	SB-21-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	4-6	0-2
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	600U	600U	15000	600U	600U	600U	600U
BENZO(A)PYRENE	300U	300U	10000	300U	300U	300U	300U
BENZO(B)FLUORANTHENE	600U	600U	11000	600U	600U	600U	600U
BENZO(G,H,I)PERYLENE	300U	300U	4000	300U	300U	300U	300U
BENZO(K)FLUORANTHENE	600U	600U	11000	600U	600U	600U	600U
CHRYSENE	600U	600U	15000	600U	600U	600U	600U
DIBENZ(A,H)ANTHRACENE	300U	300U	5000	300U	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	300U	300U	4000	300U	300U	300U	300U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	300U	300U	2000	300U	300U	300U	300U
ACENAPHTHYLENE	300U	300U	2000U	300U	300U	300U	300U
ANTHRACENE	300U	300U	4000	300U	300U	300U	300U
FLUORANTHENE	300U	300U	17000	300	300U	300U	300U
FLUORENE	300U	300U	2000	300U	300U	300U	300U
NAPHTHALENE	300U	300U	2000U	300U	300U	300U	300U
PHENANTHRENE	300U	300U	15000	300U	300U	300U	300U
PYRENE	300U	300U	15000	300	300U	300U	300U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-21-94	SB-22-94	SB-22-94	SB-23-94	SB-23-94	SB-24-94	SB-24-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-21-94 2.0-4.0	SB-22-94 0.0-2.0	SB-22-94 2.0-4.0	SB-23-94 0.0-2.0	SB-23-94 2.0-4.0	SB-24-94 0.0-2.0	SB-24-94 2.0-4.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2	2-4
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	600U	600U	600U	600U	600U	600U	600U
BENZO(A)PYRENE	300	300U	300U	300U	300U	300U	300U
BENZO(B)FLUORANTHENE	600U	600U	600U	600U	600U	600U	600U
BENZO(G,H,I)PERYLENE	300U	300U	300U	300U	300U	300U	300U
BENZO(K)FLUORANTHENE	600U	600U	600U	600U	600U	600U	600U
CHRYSENE	600U	600U	600U	600U	600U	600U	600U
DIBENZ(A,H)ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	300U	300U	300U	300U	300U	300U	300U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	300U	300U	300U	300U	300U	300U	300U
ACENAPHTHYLENE	300U	300U	300U	300U	300U	300U	300U
ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
FLUORANTHENE	400	300U	300U	300U	300U	300U	300U
FLUORENE	300U	300U	300U	300U	300U	300U	300U
NAPHTHALENE	300U	300U	300U	300U	300U	300U	300U
PHENANTHRENE	300U	300U	300U	300U	300U	300U	300U
PYRENE	300U	300U	300U	300U	300U	300U	300U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-25-94	SB-25-94	SB-26-94	SB-26-94	SB-27-94	SB-27-94	SB-28-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/08/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-25-94 0.0-2.0	SB-25-94 2.0-4.0	SB-26-94 2.0-4.0	SB-26-94 0.0-2.0	SB-27-94 0.0-2.0	SB-27-94 2.0-4.0	SB-28-94 0.0-2.0
Depth (ft):	0-2	2-4	2-4	0-2	0-2	2-4	0-2
CPAHs (ug/kg)							
BENZO(A)ANTHRACENE	600U	600U	600U	300U	600U	600U	600U
BENZO(A)PYRENE	300U	300U	300U	300U	300U	300U	300U
BENZO(B)FLUORANTHENE	600U	600U	600U	300U	600U	600U	600U
BENZO(G,H,I)PERYLENE	300U	300U	300U	300U	300U	300U	300U
BENZO(K)FLUORANTHENE	600U	600U	600U	300U	600U	600U	600U
CHRYSENE	600U	600U	600U	300U	600U	600U	600U
DIBENZ(A,H)ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	300U	300U	300U	300U	300U	300U	300U
PAHs (ug/kg)							
ACENAPHTHENE	300U	300U	300U	300U	300U	300U	300U
ACENAPHTHYLENE	300U	300U	300U	300U	300U	300U	300U
ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
FLUORANTHENE	300U	300U	300U	300U	300U	300U	300U
FLUORENE	300U	300U	300U	300U	300U	300U	300U
NAPHTHALENE	300U	300U	300U	300U	300U	300U	300U
PHENANTHRENE	300U	300U	300U	300U	300U	300U	300U
PYRENE	300U	300U	300U	300U	300U	300U	300U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-28-94	SB-29-94	SB-29-94	SB-30-94	SB-30-94	SB-31-94	SB-31-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-28-94 2.0-4.0	SB-29-94 0.0-2.0	SB-29-94 2.0-4.0	SB-30-94 0.0-2.0	SB-30-94 2.0-4.0	SB-31-94 0.0-2.0	SB-31-94 2.0-4.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2	2-4
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	600U	600U	3000U	600U	600U	600U	600U
BENZO(A)PYRENE	300U	300U	3000U	300U	300U	300U	300U
BENZO(B)FLUORANTHENE	600U	600U	3000U	600U	600U	600U	600U
BENZO(G,H,I)PERYLENE	300U	300U	3000U	300U	300U	300U	300U
BENZO(K)FLUORANTHENE	600U	600U	3000U	600U	600U	600U	600U
CHRYSENE	600U	600U	3000U	600U	600U	600U	600U
DIBENZ(A,H)ANTHRACENE	300U	300U	3000U	300U	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	300U	300U	3000U	300U	300U	300U	300U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	300U	300U	3000U	300U	300U	300U	300U
ACENAPHTHYLENE	300U	300U	3000U	300U	300U	300U	300U
ANTHRACENE	300U	300U	3000U	300U	300U	300U	300U
FLUORANTHENE	300U	300U	3000U	300U	300U	300U	300U
FLUORENE	300U	300U	3000U	300U	300U	300U	300U
NAPHTHALENE	300U	300U	3000U	300U	300U	300U	300U
PHENANTHRENE	300U	300U	3000U	300U	300U	300U	300U
PYRENE	300U	300U	3000U	300U	300U	300U	300U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-32-94	SB-32-94	SB-33-94	SB-33-94	SB-34-94	SB-34-94	SB-34-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-32-94 0.0-2.0	SB-32-94 2.0-4.0	SB-33-94 0.0-2.0	SB-33-94 2.0-4.0	SB-34-94 20-22	SB-34-94 22-24	SB-34-94 24-26
Depth (ft):	0-2	2-4	0-2	2-4	20-22	22-24	24-26
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	2000U	600U	600U	600	600U	600U	600U
BENZO(A)PYRENE	800U	300U	300U	600	300U	300U	300U
BENZO(B)FLUORANTHENE	2000U	600U	600U	800	600U	600U	600U
BENZO(G,H,I)PERYLENE	800U	300U	300U	400	300U	300U	300U
BENZO(K)FLUORANTHENE	2000U	600U	600U	800	600U	600U	600U
CHRYSENE	2000U	600U	600U	600	600U	600U	600U
DIBENZ(A,H)ANTHRACENE	800U	300U	300U	300	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	800U	300U	300U	300	300U	300U	300U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	800U	300U	300U	300U	300U	300U	300U
ACENAPHTHYLENE	800U	300U	300U	300U	300U	300U	300U
ANTHRACENE	800U	300U	300U	300U	300U	300U	300U
FLUORANTHENE	800U	300U	300U	1100	300U	300U	300U
FLUORENE	800U	300U	300U	300U	300U	300U	300U
NAPHTHALENE	800U	300U	300U	300U	300U	300U	300U
PHENANTHRENE	800U	300U	300U	700	300U	300U	300U
PYRENE	800U	300U	300U	900	300U	300U	300U

# PAH Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-34-94	SB-34-94	SB-34-94	SB-35-94	SB-35-94	SB-35-94	SB-35-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-34-94 26-28	SB-34-94 28-30	SB-34-94 30-32	SB-35-94 25-27	SB-35-94 27-29	SB-35-94 29-31	SB-35-94 31-33
Depth (ft):	26-28	28-30	30-32	25-27	27-29	29-31	31-33
<b>CPAHs (ug/kg)</b>							
BENZO(A)ANTHRACENE	600U	600U	600U	600U	600U	600U	600U
BENZO(A)PYRENE	300U	300U	300U	300U	300U	300U	300U
BENZO(B)FLUORANTHENE	600U	600U	600U	600U	600U	600U	600U
BENZO(G,H,I)PERYLENE	300U	300U	300U	300U	300U	300U	300U
BENZO(K)FLUORANTHENE	600U	600U	600U	600U	600U	600U	600U
CHRYSENE	600U	600U	600U	600U	600U	600U	600U
DIBENZ(A,H)ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
INDENO(1,2,3-C,D)PYRENE	300U	300U	300U	300U	300U	300U	300U
<b>PAHs (ug/kg)</b>							
ACENAPHTHENE	300U	300U	300U	300U	300U	300U	300U
ACENAPHTHYLENE	300U	300U	300U	300U	300U	300U	300U
ANTHRACENE	300U	300U	300U	300U	300U	300U	300U
FLUORANTHENE	300U	300U	300U	300U	300U	300U	300U
FLUORENE	300U	300U	300U	300U	300U	300U	300U
NAPHTHALENE	300U	300U	300U	300U	300U	300U	300U
PHENANTHRENE	300U	300U	300U	300U	300U	300U	300U
PYRENE	300U	300U	300U	300U	300U	300U	300U

# PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-1-94	SB-1-94	SB-2-94	SB-2-94	SB-3-94	SB-3-94	SB-4-94	SB-4-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-1-94 0.0-2.0	SB-1-94 2.0-4.0	SB-2-94 0.0-2.0	SB-2-94 2.0-4.0	SB-3-94 0.0-2.0	SB-3-94 2.0-4.0	SB-4-94 0.0-2.0	SB-4-94 2.0-4.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4	0-2	2-4

## PCBs (ug/kg)

PCB-1221(AROCHLOR1221)	500U	500U	10000U	500U	2000U	1000U	10000U	2000U
PCB-1232(AROCHLOR1232)	100U	100U	10000U	100U	500U	1000U	10000U	2000U
PCB-1242(AROCHLOR1242)	100U		10000U	100U	500U	1000U	10000U	500U
PCB-1248(AROCHLOR1248)	1100	3200	10000U	5200	4500	2000	10000	3900
PCB-1254(AROCHLOR1254)	100U	100U	10000U	100U	500U	1000U	10000U	500U
PCB-1260(AROCHLOR1260)	100U	100U	10000U	100U	500U	1000U	10000U	500U



## PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

<b>Location:</b>	<b>SB-5-94</b>	<b>SB-5-94</b>	<b>SB-6-94</b>	<b>SB-6-94</b>	<b>SB-7-94</b>	<b>SB-7-94</b>	<b>SB-8-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>
<b>Sample ID:</b>	<b>SB-5-94 0.0-2.0</b>	<b>SB-5-94 2.5-4.5</b>	<b>SB-6-94 0.0-2.0</b>	<b>SB-6-94 2.0-4.0</b>	<b>SB-7-94 0.0-2.0</b>	<b>SB-7-94 2.0-4.0</b>	<b>SB-8-94 0.0-2.0</b>
<b>Depth (ft):</b>	<b>0-2</b>	<b>2.5-4.5</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>
<b>PCBs (ug/kg)</b>							
PCB-1221(AROCHLOR1221)	500U	2000U	500U	2000U	500U	500U	2000U
PCB-1232(AROCHLOR1232)	100U	500U	100U	500U	100U	100U	500U
PCB-1242(AROCHLOR1242)	100U	500U	100U	500U	100U	100U	500U
PCB-1248(AROCHLOR1248)	<b>1300</b>	<b>2400</b>	<b>200</b>	<b>500</b>	<b>6900</b>	<b>400</b>	<b>1900</b>
PCB-1254(AROCHLOR1254)	100U	500U	100U	500U	100U	100U	500U
PCB-1260(AROCHLOR1260)	100U	500U	100U	500U	100U	100U	500U

# PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-8-94	SB-9-94	SB-9-94	SB-10-94	SB-10-94	SB-11-94	SB-11-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-8-94 2.0-4.0	SB-9-94 0.0-2.0	SB-9-94 2.0-4.0	SB-10-94 0.0-2.0	SB-10-94 2.0-4.0	SB-11-94 0.0-2.0	SB-11-94 2.0-4.0
Depth (ft):	2-4	0-2	4-4	0-2	2-4	0-2	2-4

## PCBs (ug/kg)

PCB-1221(AROCHLOR1221)	500U	500U	500U	1000U	500U	10000U	500U
PCB-1232(AROCHLOR1232)	100U	100U	100U	200U	100U	10000U	100U
PCB-1242(AROCHLOR1242)	100U	100U	100U	200U	100U	10000U	100U
PCB-1248(AROCHLOR1248)	800	2900	200	24000	500	50000	100U
PCB-1254(AROCHLOR1254)	100U	100U	100U	200U	100U	10000U	100U
PCB-1260(AROCHLOR1260)	100U	100U	100U	200U	100U	10000U	100U

## PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

<b>Location:</b>	<b>SB-12-94</b>	<b>SB-12-94</b>	<b>SB-13-94</b>	<b>SB-13-94</b>	<b>SB-14-94</b>	<b>SB-14-94</b>	<b>SB-15-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>
<b>Sample ID:</b>	<b>SB-12-94 0.0-2.0</b>	<b>SB-12-94 2.0-4.0</b>	<b>SB-13-94 0.0-2.0</b>	<b>SB-13-94 2.0-4.0</b>	<b>SB-14-94 0.0-2.0</b>	<b>SB-14-94 2.0-4.0</b>	<b>SB-15-94 0.0-2.0</b>
<b>Depth (ft):</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>

### PCBs (ug/kg)

PCB-1221(AROCHLOR1221)	500U	500U	500U	500U	500U	500U	500U
PCB-1232(AROCHLOR1232)	100U	100U	100U	100U	100U	100U	100U
PCB-1242(AROCHLOR1242)	100U	100U	100U	100U	100U	100U	100U
PCB-1248(AROCHLOR1248)	<b>9200</b>	<b>2000</b>	<b>6100</b>	<b>2300</b>	<b>4800</b>	<b>14000</b>	<b>7600</b>
PCB-1254(AROCHLOR1254)	100U	100U	100U	100U	100U	100U	100U
PCB-1260(AROCHLOR1260)	100U	100U	100U	100U	100U	100U	100U

## PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

<b>Location:</b>	<b>SB-15-94</b>	<b>SB-16-94</b>	<b>SB-16-94</b>	<b>SB-17-94</b>	<b>SB-17-94</b>	<b>SB-18-94</b>	<b>SB-18-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>
<b>Sample ID:</b>	<b>SB-15-94 2.0-4.0</b>	<b>SB-16-94 0.0-2.0</b>	<b>SB-16-94 2.0-4.0</b>	<b>SB-17-94 0.0-2.0</b>	<b>SB-17-94 2.0-4.0</b>	<b>SB-18-94 0.0-2.0</b>	<b>SB-18-94 2.0-4.0</b>
<b>Depth (ft):</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>

### PCBs (ug/kg)

PCB-1221(AROCHLOR1221)	500U	500U	500U	500U	500U	500U	500U
PCB-1232(AROCHLOR1232)	100U	100U	100U	100U	100U	100U	100U
PCB-1242(AROCHLOR1242)	100U	100U	100U	100U	100U	100U	100U
PCB-1248(AROCHLOR1248)	3300	4800	3700	20000	120000	17000	33000
PCB-1254(AROCHLOR1254)	100U	100U	100U	100U	100U	100U	100U
PCB-1260(AROCHLOR1260)	100U	100U	100U	100U	100U	100U	100U

## PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

<b>Location:</b>	<b>SB-19-94</b>	<b>SB-19-94</b>	<b>SB-19-94</b>	<b>SB-20-94</b>	<b>SB-20-94</b>	<b>SB-20-94</b>	<b>SB-21-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>
<b>Sample ID:</b>	<b>SB-19-94 0.0-2.0</b>	<b>SB-19-94 2.0-4.0</b>	<b>SB-19-94 2.0-4.0</b>	<b>SB-20-94 0.0-2.0</b>	<b>SB-20-94 2.0-4.0</b>	<b>SB-20-94 4.0-6.0</b>	<b>SB-21-94 0.0-2.0</b>
<b>Depth (ft):</b>	<b>0-2</b>	<b>2-4</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>4-6</b>	<b>0-2</b>
<b>PCBs (ug/kg)</b>							
PCB-1221(AROCHLOR1221)	500U		2000U	500U	500U	500U	500U
PCB-1232(AROCHLOR1232)	100U		500U	100U	100U	100U	100U
PCB-1242(AROCHLOR1242)	100U		500U	100U	100U	100U	100U
PCB-1248(AROCHLOR1248)	<b>7200</b>	<b>2.8</b>	<b>2600</b>	<b>21000</b>	<b>36000</b>	<b>8900</b>	<b>12000</b>
PCB-1254(AROCHLOR1254)	100U		500U	100U	100U	100U	100U
PCB-1260(AROCHLOR1260)	100U		500U	100U	100U	100U	100U

## PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-21-94	SB-22-94	SB-22-94	SB-23-94	SB-23-94	SB-24-94	SB-24-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-21-94 2.0-4.0	SB-22-94 0.0-2.0	SB-22-94 2.0-4.0	SB-23-94 0.0-2.0	SB-23-94 2.0-4.0	SB-24-94 0.0-2.0	SB-24-94 2.0-4.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2	2-4

### PCBs (ug/kg)

PCB-1221(AROCHLOR1221)	500U	500U	500U	500U	500U	500U	500U
PCB-1232(AROCHLOR1232)	100U	100U	100U	100U	100U	100U	100U
PCB-1242(AROCHLOR1242)	100U	100U	100U	100U	100U	100U	100U
PCB-1248(AROCHLOR1248)	56000	100U	300	200	50000	6500	100
PCB-1254(AROCHLOR1254)	100U	100U	100U	100U	100U	100U	100U
PCB-1260(AROCHLOR1260)	100U	100U	100U	100U	100U	100U	100U

## PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

<b>Location:</b>	<b>SB-25-94</b>	<b>SB-25-94</b>	<b>SB-26-94</b>	<b>SB-26-94</b>	<b>SB-27-94</b>	<b>SB-27-94</b>	<b>SB-28-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/08/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>
<b>Sample ID:</b>	<b>SB-25-94 0.0-2.0</b>	<b>SB-25-94 2.0-4.0</b>	<b>SB-26-94 2.0-4.0</b>	<b>SB-26-94 0.0-2.0</b>	<b>SB-27-94 0.0-2.0</b>	<b>SB-27-94 2.0-4.0</b>	<b>SB-28-94 0.0-2.0</b>
<b>Depth (ft):</b>	<b>0-2</b>	<b>2-4</b>	<b>2-4</b>	<b>0-2</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>
<b>PCBs (ug/kg)</b>							
PCB-1221(AROCHLOR1221)	500U	500U	500U	1000U	500U	500U	500U
PCB-1232(AROCHLOR1232)	100U	100U	100U	1000U	100U	100U	100U
PCB-1242(AROCHLOR1242)	100U	100U	100U	1000U	100U	100U	100U
PCB-1248(AROCHLOR1248)	100U	300U	<b>1600</b>	<b>99000</b>	<b>21000</b>	<b>69000</b>	<b>700</b>
PCB-1254(AROCHLOR1254)	100U	100U	100U	1000U	100U	100U	100U
PCB-1260(AROCHLOR1260)	100U	100U	100U	1000U	100U	100U	100U



# PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

<b>Location:</b>	<b>SB-28-94</b>	<b>SB-29-94</b>	<b>SB-29-94</b>	<b>SB-30-94</b>	<b>SB-30-94</b>	<b>SB-31-94</b>	<b>SB-31-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/08/1994</b>	<b>11/08/1994</b>	<b>11/08/1994</b>	<b>11/08/1994</b>
<b>Sample ID:</b>	<b>SB-28-94 2.0-4.0</b>	<b>SB-29-94 0.0-2.0</b>	<b>SB-29-94 2.0-4.0</b>	<b>SB-30-94 0.0-2.0</b>	<b>SB-30-94 2.0-4.0</b>	<b>SB-31-94 0.0-2.0</b>	<b>SB-31-94 2.0-4.0</b>
<b>Depth (ft):</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>

## PCBs (ug/kg)

PCB-1221(AROCHLOR1221)	500U	500U	10000U	500U	500U	500U	500U
PCB-1232(AROCHLOR1232)	100U	100U	10000U	100U	100U	100U	100U
PCB-1242(AROCHLOR1242)	100U	100U	10000U	100U	100U	100U	100U
PCB-1248(AROCHLOR1248)	100	700	10000U	3300	200	100	300
PCB-1254(AROCHLOR1254)	100U	100U	10000U	100U	100U	100U	100U
PCB-1260(AROCHLOR1260)	100U	100U	10000U	100U	100U	100U	100U

## PCB Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-32-94	SB-32-94	SB-33-94	SB-33-94
Sample Matrix:	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-32-94 0.0-2.0	SB-32-94 2.0-4.0	SB-33-94 0.0-2.0	SB-33-94 2.0-4.0
Depth (ft):	0-2	2-4	0-2	2-4

### PCBs (ug/kg)

PCB-1221(AROCHLOR1221)	1000U	500U	500U	500U
PCB-1232(AROCHLOR1232)	200U	100U	100U	100U
PCB-1242(AROCHLOR1242)	200U	100U	100U	100U
PCB-1248(AROCHLOR1248)	200U	5200	10000	23000
PCB-1254(AROCHLOR1254)	200U	100U	100U	100U
PCB-1260(AROCHLOR1260)	200U	100U	100U	100U

**Esters and General Chemicals Soil Samples**  
**(Results from Ann Arbor Technical Services, 1994)**

Location:	SB-1-94	SB-1-94	SB-2-94	SB-3-94	SB-4-94	SB-5-94	SB-5-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-1-94 0.0-2.0	SB-1-94 2.0-4.0	SB-2-94 2.0-4.0	SB-3-94 0.0-2.0	SB-4-94 2.0-4.0	SB-5-94 0.0-2.0	SB-5-94 2.5-4.5
Depth (ft):	0-2	2-4	2-4	0-2	2-4	0-2	2.5-4.5

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	100U	100U	500U	700	100U	500U
Location:	SB-1-94	SB-1-94	SB-2-94	SB-2-94	SB-3-94	SB-3-94	SB-4-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-1-94 0.0-2.0	SB-1-94 2.0-4.0	SB-2-94 0.0-2.0	SB-2-94 2.0-4.0	SB-3-94 0.0-2.0	SB-3-94 2.0-4.0	SB-4-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4	0-2

**General Chemicals (%wt/wt)**

TOTALSOLIDS	91.1	87.5	94.3	87.3	93.1	91.5	96.5
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## Esters and General Chemicals Soil Samples

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-6-94	SB-6-94	SB-7-94	SB-7-94	SB-8-94	SB-8-94	SB-9-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-6-94 0.0-2.0	SB-6-94 2.0-4.0	SB-7-94 0.0-2.0	SB-7-94 2.0-4.0	SB-8-94 0.0-2.0	SB-8-94 2.0-4.0	SB-9-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4	0-2

### Esters (ug/kg)

TRIPHENYLPHOSPHATE	100U	500U	100U	100U	500U	100U	100U
Location:	SB-4-94	SB-5-94	SB-5-94	SB-6-94	SB-6-94	SB-7-94	SB-7-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-4-94 2.0-4.0	SB-5-94 0.0-2.0	SB-5-94 2.5-4.5	SB-6-94 0.0-2.0	SB-6-94 2.0-4.0	SB-7-94 0.0-2.0	SB-7-94 2.0-4.0
Depth (ft):	2-4	0-2	2.5-4.5	0-2	2-4	0-2	2-4

### General Chemicals (%wt/wt)

TOTALSOLIDS	89.1	94.6	89.7	93.9	93.4	94.9	83.9
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**Esters and General Chemicals Soil Samples**  
 (Results from Ann Arbor Technical Services, 1994)

Location:	SB-9-94	SB-10-94	SB-10-94	SB-11-94	SB-12-94	SB-12-94	SB-13-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-9-94 2.0-4.0	SB-10-94 0.0-2.0	SB-10-94 2.0-4.0	SB-11-94 2.0-4.0	SB-12-94 0.0-2.0	SB-12-94 2.0-4.0	SB-13-94 0.0-2.0
Depth (ft):	4-4	0-2	2-4	2-4	0-2	2-4	0-2

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	200U	100U	100U	100U	100U	100U
Location:	SB-8-94	SB-8-94	SB-9-94	SB-9-94	SB-10-94	SB-10-94	SB-11-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-8-94 0.0-2.0	SB-8-94 2.0-4.0	SB-9-94 0.0-2.0	SB-9-94 2.0-4.0	SB-10-94 0.0-2.0	SB-10-94 2.0-4.0	SB-11-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	4-4	0-2	2-4	0-2

**General Chemicals (%wt/wt)**

TOTALSOLIDS	95.1	85.9	95.3	90.2	94.3	82.2	91.8
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**Esters and General Chemicals Soil Samples**

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-13-94	SB-14-94	SB-14-94	SB-15-94	SB-15-94	SB-16-94	SB-16-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-13-94 2.0-4.0	SB-14-94 0.0-2.0	SB-14-94 2.0-4.0	SB-15-94 0.0-2.0	SB-15-94 2.0-4.0	SB-16-94 0.0-2.0	SB-16-94 2.0-4.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2	2-4

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	100U	100U	100U	100U	100U	100U
Location:	SB-11-94	SB-12-94	SB-12-94	SB-13-94	SB-13-94	SB-14-94	SB-14-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-11-94 2.0-4.0	SB-12-94 0.0-2.0	SB-12-94 2.0-4.0	SB-13-94 0.0-2.0	SB-13-94 2.0-4.0	SB-14-94 0.0-2.0	SB-14-94 2.0-4.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2	2-4

**General Chemicals (%wt/wt)**

TOTALSOLIDS	88.0	958	90.0	94.3	87.0	93.4	82.5
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**Esters and General Chemicals Soil Samples**  
**(Results from Ann Arbor Technical Services, 1994)**

<b>Location:</b>	<b>SB-17-94</b>	<b>SB-17-94</b>	<b>SB-18-94</b>	<b>SB-18-94</b>	<b>SB-19-94</b>	<b>SB-19-94</b>	<b>SB-20-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>
<b>Sample ID:</b>	<b>SB-17-94 0.0-2.0</b>	<b>SB-17-94 2.0-4.0</b>	<b>SB-18-94 0.0-2.0</b>	<b>SB-18-94 2.0-4.0</b>	<b>SB-19-94 0.0-2.0</b>	<b>SB-19-94 2.0-4.0</b>	<b>SB-20-94 0.0-2.0</b>
<b>Depth (ft):</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>

**Esters (ug/kg)**

<b>TRIPHENYLPHOSPHATE</b>	<b>100U</b>	<b>100U</b>	<b>100U</b>	<b>100U</b>	<b>100U</b>	<b>500U</b>	<b>100U</b>
<b>Location:</b>	<b>SB-15-94</b>	<b>SB-15-94</b>	<b>SB-16-94</b>	<b>SB-16-94</b>	<b>SB-17-94</b>	<b>SB-17-94</b>	<b>SB-18-94</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>	<b>11/07/1994</b>
<b>Sample ID:</b>	<b>SB-15-94 0.0-2.0</b>	<b>SB-15-94 2.0-4.0</b>	<b>SB-16-94 0.0-2.0</b>	<b>SB-16-94 2.0-4.0</b>	<b>SB-17-94 0.0-2.0</b>	<b>SB-17-94 2.0-4.0</b>	<b>SB-18-94 0.0-2.0</b>
<b>Depth (ft):</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>	<b>2-4</b>	<b>0-2</b>

**General Chemicals (%wt/wt)**

<b>TOTALSOLIDS</b>	<b>94.6</b>	<b>93.2</b>	<b>94.6</b>	<b>87.4</b>	<b>94.0</b>	<b>83.9</b>	<b>94.6</b>
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# **Esters and General Chemicals Soil Samples**

(Results from Ann Arbor Technical Services, 1994)

Location:	SB-20-94	SB-20-94	SB-21-94	SB-21-94	SB-22-94	SB-22-94	SB-23-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-20-94 2.0-4.0	SB-20-94 4.0-6.0	SB-21-94 0.0-2.0	SB-21-94 2.0-4.0	SB-22-94 0.0-2.0	SB-22-94 2.0-4.0	SB-23-94 0.0-2.0
Depth (ft):	2-4	4-6	0-2	2-4	0-2	2-4	0-2

## **Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	100U	100U	100U	100U	100U	100U
Location:	SB-18-94	SB-19-94	SB-19-94	SB-20-94	SB-20-94	SB-21-94	SB-21-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-18-94 2.0-4.0	SB-19-94 0.0-2.0	SB-19-94 2.0-4.0	SB-20-94 0.0-2.0	SB-20-94 2.0-4.0	SB-21-94 0.0-2.0	SB-21-94 2.0-4.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	0-2	2-4

## **General Chemicals (%wt/wt)**

TOTALSOLIDS	92.0	95.8	91.6	94.3	91.6	94.8	91.0
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**Esters and General Chemicals Soil Samples**  
(Results from Ann Arbor Technical Services, 1994)

Location:	SB-23-94	SB-24-94	SB-24-94	SB-25-94	SB-25-94	SB-26-94	SB-27-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-23-94 2.0-4.0	SB-24-94 0.0-2.0	SB-24-94 2.0-4.0	SB-25-94 0.0-2.0	SB-25-94 2.0-4.0	SB-26-94 2.0-4.0	SB-27-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	2-4	2-4	0-2

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	100U	100U	100U	100U	100U	100U
Location:	SB-22-94	SB-22-94	SB-23-94	SB-23-94	SB-24-94	SB-24-94	SB-25-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-22-94 0.0-2.0	SB-22-94 2.0-4.0	SB-23-94 0.0-2.0	SB-23-94 2.0-4.0	SB-24-94 0.0-2.0	SB-24-94 2.0-4.0	SB-25-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4	0-2

**General Chemicals (%wt/wt)**

TOTALSOLIDS	94.7	96.1	95.2	88.3	95.8	82.3	95.0
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**Esters and General Chemicals Soil Samples**  
(Results from Ann Arbor Technical Services, 1994)

Location:	SB-27-94	SB-28-94	SB-28-94	SB-29-94	SB-30-94	SB-30-94	SB-31-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/07/1994	11/07/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-27-94 2.0-4.0	SB-28-94 0.0-2.0	SB-28-94 2.0-4.0	SB-29-94 0.0-2.0	SB-30-94 0.0-2.0	SB-30-94 2.0-4.0	SB-31-94 0.0-2.0
Depth (ft):	2-4	0-2	2-4	0-2	0-2	2-4	0-2

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	100U	100U	100U	100U	100U	100U
Location:	SB-25-94	SB-26-94	SB-26-94	SB-27-94	SB-27-94	SB-28-94	SB-28-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/08/1994	11/07/1994	11/07/1994	11/07/1994	11/07/1994
Sample ID:	SB-25-94 2.0-4.0	SB-26-94 2.0-4.0	SB-26-94 0.0-2.0	SB-27-94 0.0-2.0	SB-27-94 2.0-4.0	SB-28-94 0.0-2.0	SB-28-94 2.0-4.0
Depth (ft):	2-4	2-4	0-2	0-2	2-4	0-2	2-4

**General Chemicals (%wt/wt)**

TOTALSOLIDS	98.4	87.9	95.2	95.4	93.6	95.4	95.1
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**Esters and General Chemicals Soil Samples**  
(Results from Ann Arbor Technical Services, 1994)

Location:	SB-31-94	SB-32-94	SB-32-94	SB-33-94	SB-33-94	SB-34-94	SB-34-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-31-94 2.0-4.0	SB-32-94 0.0-2.0	SB-32-94 2.0-4.0	SB-33-94 0.0-2.0	SB-33-94 2.0-4.0	SB-34-94 20-22	SB-34-94 22-24
Depth (ft):	2-4	0-2	2-4	0-2	2-4	20-22	22-24

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	200U	100U	100U	100U	100U	100U
Location:	SB-29-94	SB-29-94	SB-30-94	SB-30-94	SB-31-94	SB-31-94	SB-32-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/07/1994	11/07/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-29-94 0.0-2.0	SB-29-94 2.0-4.0	SB-30-94 0.0-2.0	SB-30-94 2.0-4.0	SB-31-94 0.0-2.0	SB-31-94 2.0-4.0	SB-32-94 0.0-2.0
Depth (ft):	0-2	2-4	0-2	2-4	0-2	2-4	0-2

**General Chemicals (%wt/wt)**

TOTALSOLIDS	96.0	93.7	96.4	91.4	95.5	97.6	91.5
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**Esters and General Chemicals Soil Samples**  
**(Results from Ann Arbor Technical Services, 1994)**

Location:	SB-34-94	SB-34-94	SB-34-94	SB-34-94	SB-35-94	SB-35-94	SB-35-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-34-94 24-26	SB-34-94 26-28	SB-34-94 28-30	SB-34-94 30-32	SB-35-94 25-27	SB-35-94 27-29	SB-35-94 29-31
Depth (ft):	24-26	26-28	28-30	30-32	25-27	27-29	29-31

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U	100U	100U	100U	100U	100U	100U
Location:	SB-32-94	SB-33-94	SB-33-94	SB-34-94	SB-34-94	SB-34-94	SB-34-94
Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-32-94 2.0-4.0	SB-33-94 0.0-2.0	SB-33-94 2.0-4.0	SB-34-94 20-22	SB-34-94 22-24	SB-34-94 24-26	SB-34-94 26-28
Depth (ft):	2-4	0-2	2-4	20-22	22-24	24-26	26-28

**General Chemicals (%wt/wt)**

TOTALSOLIDS	89.3	94.5	82.7	84.8	79.9	81.0	81.0
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**Esters and General Chemicals Soil Samples**  
**(Results from Ann Arbor Technical Services, 1994)**

Location:	SB-35-94
Sample Matrix:	SO
Sample Date:	11/08/1994
Sample ID:	SB-35-94 31-33
Depth (ft):	31-33

**Esters (ug/kg)**

TRIPHENYLPHOSPHATE	100U					
Location:	SB-34-94	SB-34-94	SB-35-94	SB-35-94	SB-35-94	SB-35-94
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994	11/08/1994
Sample ID:	SB-34-94 28-30	SB-34-94 30-32	SB-35-94 25-27	SB-35-94 27-29	SB-35-94 29-31	SB-35-94 31-33
Depth (ft):	28-30	30-32	25-27	27-29	29-31	31-33

**General Chemicals (%wt/wt)**

TOTALSOLIDS	78.6	88.6	79.3	81100	76.0	87.2
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**First Environmental Laboratories**  
**(December 1998)**

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**VOC Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	HY-34-98	HY-34-98	HY-34-98	HY-35-98	HY-35-98	HY-36-98	HY-36-98
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	12/09/1998	12/09/1998	12/09/1998	12/10/1998	12/10/1998	12/09/1998	12/09/1998
	Sample ID:	67907	67908	67909	68142	68143	67905	67906
	Depth (ft):	15-17	15-17	25-27	15-17	25-27	15-17	25-27
<b>VOCs (ug/L)</b>								
1,1,2,2-TETRACHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
1,1,2-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
1,2-DICHLOROPROPANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
BROMODICHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
BROMOFORM		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
BROMOMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
CARBONDISULFIDE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CARBONTETRACHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROFORM		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
CIS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
DIBROMOCHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
METHYLENECHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
METHYLETHYLKETONE(2-BUTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
VINYLACETATE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U

**VOC Results in Water**  
(Results from First Environmental, 1998)

	Location:	HY-34-98	HY-34-98	HY-34-98	HY-35-98	HY-35-98	HY-36-98	HY-36-98
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	12/09/1998	12/09/1998	12/09/1998	12/10/1998	12/10/1998	12/09/1998	12/09/1998
	Sample ID:	67907	67908	67909	68142	68143	67905	67906
	Depth (ft):	15-17	15-17	25-27	15-17	25-27	15-17	25-27
<b>CVOCs (ug/L)</b>								
1,1,1-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
1,1-DICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	17.9	5.0U	5.0U
1,1-DICHLOROETHENE		5.0U	5.0U	5.0U	5.0U	22.5	5.0U	5.0U
1,2-DICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROETHANE		10.0U	10.0U	10.0U	905	10.0U	10.0U	10.0U
CIS-1,2-DICHLOROETHYLENE		791	531	3100	5.0U	28300	9.5	14.1
TETRACHLOROETHYLENE(PCE)		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,2-DICHLOROETHENE		31.3	31.1	29.7	5.0U	122	5.0U	5.0U
TRICHLOROETHYLENE(TCE)		11.0	11.1	25100	23.4	7990	5.0U	5.0U
VINYLCHLORIDE		30.0	30.9	11.2	10.0U	117	25.6	10.0U
<b>BTEXs (ug/L)</b>								
BENZENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
ETHYLBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
TOLUENE		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U
XYLENES,TOTAL		5.0U	5.0U	5.0U	5.0U	5.0U	5.0U	5.0U

**General Chemicals and Metals Results in Water**  
(Results from First Environmental, 1998)

	Location:	HY-34-98	HY-34-98	HY-34-98	HY-35-98	HY-35-98	HY-36-98	HY-36-98
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	12/09/1998	12/09/1998	12/09/1998	12/10/1998	12/10/1998	12/09/1998	12/09/1998
	Sample ID:	67907	67908	67909	68142	68143	67905	67906
	Depth (ft):	15-17	15-17	25-27	15-17	25-27	15-17	25-27
<b>General Chemicals (ug/L)</b>								
ALKALINITY,TOTAL(ASCACO3)		280000	270000	340000	550000	400000	280000	360000
CHLORIDE(ASCL)		398000	393000	133000	187000	361000	245000	250000
NITROGEN,AMMONIA(ASN)		460	480	5430	2250	6300	5430	4520
NITROGEN,KJELDAHL,TOTAL		740	550	5430	3800	6800	5430	4520
NITROGEN,NITRATE-NITRITE		140	100	640	960	1040	300	420
PHOSPHORUS,TOTAL(ASP)		10U	10U	10U	100	10U	70	10U
PHOSPHORUS,TOTALORTHOPHOSPHATE(ASPO4)		10U	10U	10U	10U	10U	10U	10U
SULFATE(ASSO4)		81000	82000	71000	15000	426000	99000	152000
SULFIDE		50U	50U	50U	50U	50U	50U	50U
TOTALDISSOLVEDSOLIDS(RESIDUE,FILTERABLE)		1230000	1230000	708000	1070000	2730000	920000	1120000
TOTALORGANICCARBON		3300	3900	8500	38100	9800	6500	8700
<b>Metals (ug/L)</b>								
CALCIUM		176000	178000	150000	406000	956000	152000	171000
IRON		3800	2800	5500	39700	72800	9400	8200
MAGNESIUM		53800	53900	66000	92700	288000	53400	70800
POTASSIUM		5900	5600	4800	22700	20900	5400	3800
SODIUM		265000	262000	89400	202000	351000	164000	210000

**VOC Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	TP-13-98	TP-13-98	TP-16-98	W-4A-98	W-4C-98
	Sample Matrix:	WG	WG	WG	WG	WG
	Sample Date:	12/10/1998	12/11/1998	12/11/1998	12/11/1998	12/11/1998
	Sample ID:	68144	68145	68148	68146	68147
	Depth (ft):	15-17	25-27	25-27	2-4	25-27
<b>VOCs (ug/L)</b>						
1,1,2,2-TETRACHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
1,1,2-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
1,2-DICHLOROPROPANE		5.0U	5.0U	5.0U	5.0U	5.0U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		10.0U	10.0U	10.0U	10.0U	10.0U
BROMODICHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
BROMOFORM		5.0U	5.0U	5.0U	5.0U	5.0U
BROMOMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U
CARBONDISULFIDE		5.0U	5.0U	5.0U	5.0U	5.0U
CARBONTETRACHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROFORM		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROMETHANE		10.0U	10.0U	10.0U	10.0U	10.0U
CIS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U
DIBROMOCHLOROMETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
METHYLENECHLORIDE		5.0U	5.0U	5.0U	5.0U	5.0U
METHYLETHYLKETONE(2-BUTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,3-DICHLOROPROPENE		5.0U	5.0U	5.0U	5.0U	5.0U
VINYLACETATE		10.0U	10.0U	10.0U	10.0U	10.0U

**VOC Results in Water**  
**(Results from First Environmental, 1998)**

	<b>Location:</b>	<b>TP-13-98</b>	<b>TP-13-98</b>	<b>TP-16-98</b>	<b>W-4A-98</b>	<b>W-4C-98</b>
	<b>Sample Matrix:</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>	<b>WG</b>
	<b>Sample Date:</b>	<b>12/10/1998</b>	<b>12/11/1998</b>	<b>12/11/1998</b>	<b>12/11/1998</b>	<b>12/11/1998</b>
	<b>Sample ID:</b>	<b>68144</b>	<b>68145</b>	<b>68148</b>	<b>68146</b>	<b>68147</b>
	<b>Depth (ft):</b>	<b>15-17</b>	<b>25-27</b>	<b>25-27</b>	<b>2-4</b>	<b>25-27</b>
<b>CVOCs (ug/L)</b>						
1,1,1-TRICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
1,1-DICHLOROETHANE		5.0U	5.0U	29.7	5.0U	5.0U
1,1-DICHLOROETHENE		84.1	97.4	11.5	5.0U	5.0U
1,2-DICHLOROETHANE		5.0U	5.0U	5.0U	5.0U	5.0U
CHLOROETHANE		10.0U	10.0U	10.0U	10.0U	10.0U
CIS-1,2-DICHLOROETHYLENE		29400	55600	16400	770	5.0U
TETRACHLOROETHYLENE(PCE)		5.0U	5.0U	5.0U	5.0U	5.0U
TRANS-1,2-DICHLOROETHENE		198	301	106	10.6	5.0U
TRICHLOROETHYLENE(TCE)		18400	170	27900	6.0	5.0U
VINYLCHLORIDE		344	1400	10.0U	184	10.0U
<b>BTEXs (ug/L)</b>						
BENZENE		5.0U	5.0U	5.0U	5.0U	12.7
ETHYLBENZENE		5.0U	5.0U	5.0U	5.0U	5.0U
TOLUENE		5.0U	5.0U	5.0U	5.0U	5.0U
XYLENES,TOTAL		5.0U	5.0U	5.0U	5.0U	5.0U

**General Chemicals and Metals Results in Water**  
**(Results from First Environmental, 1998)**

	Location:	TP-13-98	TP-13-98	TP-16-98	W-4A-98	W-4C-98
	Sample Matrix:	WG	WG	WG	WG	WG
	Sample Date:	12/10/1998	12/11/1998	12/11/1998	12/11/1998	12/11/1998
	Sample ID:	68144	68145	68148	68146	68147
	Depth (ft):	15-17	25-27	25-27	2-4	25-27
<b>General Chemicals (ug/L)</b>						
ALKALINITY,TOTAL(ASCACO3)		330000	310000	340000	300000	390000
CHLORIDE(ASCL)		305000	544000	319000	605000	122000
NITROGEN,AMMONIA(ASN)		1120	4120	4350	940	12000
NITROGEN,KJELDAHL,TOTAL		1500	4120	4350	1900	12000
NITROGEN,NITRATE-NITRITE		110	450	490	540	120
PHOSPHORUS,TOTAL(ASP)		10U	10U	10U	10U	280
PHOSPHORUS,TOTALORTHOPHOSPHATE(ASPO4)		10U	10U	10U	10U	200
SULFATE(ASSO4)		91000	100000	314000	105000	40000
SULFIDE		50U	50U	50U	50U	50U
TOTALDISSOLVEDSOLIDS(RESIDUE,FILTERABLE)		945000	1500000	1500000	1610000	673000
TOTALORGANICCARBON		6100	8500	5400	4500	17000
<b>Metals (ug/L)</b>						
CALCIUM		81500	370000	407000	294000	220000
IRON		9480	28500	9700	7910	780
MAGNESIUM		45500	60200	63200	91600	67100
POTASSIUM		7700	9300	6200	6000	6900
SODIUM		545000	458000	375000	650000	198000

**Microseeps**  
**(January 1999)**

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**Ethane and Ethene Results in Water**  
**(Results from Microseeps, 1999)**

Location:	HY-34-98	HY-34-98	HY-34-98	HY-35-98	HY-35-98	TP-13-98	TP-13-98	TP-16-98	W-4A-98	W-4C-98
Sample Matrix:	WG	WG	WG	WG	WG	WG	WG	WG	WG	WG
Sample Date:	12/09/1998	12/09/1998	12/09/1998	12/10/1998	12/10/1998	12/10/1998	12/11/1998	12/11/1998	12/11/1998	12/11/1998
Sample ID:	HY34B-077	HY34B-078	HY34C-079	HY35B-080	HY35C-081	TP13B-082	TP13C-083	TP16C-086	W4A-084	W4C-085
Depth (ft):	15-17	15-17	25-27	15-17	25-27	15-17	25-27	25-27	2-4	25-27
<b>Ethane and Ethene (ng/L)</b>										
ETHANE	37	27	2165	1438914	1080	6695	1941	282	163	4584
ETHENE	570	480	1961	68	883	11537	59204	285	15485	81

**STS Consultants, Ltd.**  
**(September 1999)**

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## VOC Results in Water

(Results from STS Consultants, 1999)

Location:	VP-01-98	VP-01-98
Sample Matrix:	WG	WG
Sample Date:	12/10/1998	12/10/1998
Sample ID:	VP-01 6	VP-01 17
Depth (ft):	6-6	17-17

### BTEX (ug/L)

BENZENE	1.0U	1.3
ETHYLBENZENE	1.0U	1.0U
TOLUENE	1.0U	1.0U
XYLENES,TOTAL	1.0U	1.0U

## SVOC Results in Water

(Results from STS Consultants, 1999)

Location:	VP-01-98	VP-01-98	VP-01-98	VP-01-98
Sample Matrix:	WG	WG	WG	WG
Sample Date:	12/10/1998	12/10/1998	12/10/1998	12/10/1998
Sample ID:	VP-01 6 Filtered	VP-01 6 Unfiltered	VP-01 17 Filtered	VP-01 17 Unfiltered
Depth (ft):	6-6	6-6	17-17	17-17

### CPAHs (ug/L)

BENZO(A)ANTHRACENE	0.13U	0.18	0.13U	0.13U
BENZO(A)PYRENE	0.23U	0.23U	0.23U	0.23U
BENZO(B)FLUORANTHENE	0.18U	0.16U	0.18U	0.18U
BENZO(G,H,I)PERYLENE	0.76U	0.76U	0.76U	0.76U
BENZO(K)FLUORANTHENE	0.17U	0.17U	0.17U	0.17U
CHRYSENE	0.5U	0.5U	0.5U	0.5U
DIBENZ(A,H)ANTHRACENE	0.3U	0.3U	0.3U	0.3U
INDENO(1,2,3-C,D)PYRENE	0.43U	0.43U	0.43U	0.43U

### PAHs (ug/L)

ACENAPHTHENE	0.5U	0.56	0.5U	0.5U
ACENAPHTHYLENE	0.5U	0.5U	0.5U	0.5U
ANTHRACENE	0.5U	0.5U	0.5U	0.5U
FLUORANTHENE	0.5U	0.5U	0.5U	0.5U
FLUORENE	0.5U	0.5U	0.5U	0.5U
NAPHTHALENE	3.4	3.2	0.76	0.65
PHENANTHRENE	1U	1U	1U	1U
PYRENE	0.5U	0.5U	0.5U	0.5U

**Metals Results in Water**  
(Results from STS Consultants, 1999)

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Location:	MWPL-205-99
Sample Matrix:	WG
Sample Date:	04/14/1999
Sample ID:	MWPL-205U
Depth (ft):	2-12

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**Metals (ug/L)**

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ARSENIC	50.2
BARIUM	63
CADMIUM	10U
CHROMIUM,TOTAL	40U

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**SVOC Results in Soil**  
**(Results from STS Consultants, 1999)**

<b>Location:</b>	<b>PL2SB01-97</b>	<b>PL2SB02-97</b>
<b>Sample Matrix:</b>	<b>SO</b>	<b>SO</b>
<b>Sample Date:</b>	<b>12/10/1998</b>	<b>12/10/1998</b>
<b>Sample ID:</b>	<b>PL2SB01 0-2</b>	<b>PL2SB02 0-2</b>
<b>Depth (ft):</b>	<b>0-2</b>	<b>0-2</b>

**CPAHs (ug/kg)**

BENZO(A)ANTHRACENE	500	130
BENZO(A)PYRENE	510	69
BENZO(B)FLUORANTHENE	440	100
BENZO(G,H,I)PERYLENE	460	100
BENZO(K)FLUORANTHENE	240	65
CHRYSENE	440	130
DIBENZ(A,H)ANTHRACENE	670	16
INDENO(1,2,3-C,D)PYRENE	370	77

**PAHs (ug/kg)**

ACENAPHTHENE	100U	41
ACENAPHTHYLENE	100U	21U
ANTHRACENE	300	48
FLUORANTHENE	1700	500
FLUORENE	290	55
NAPHTHALENE	330	45
PHENANTHRENE	1200	31
PYRENE	1100	240

# PCB Results in Soil

(Results from STS Consultants, 1999)

Location:	PL2SB02-97	PL2SB02-97	PL2SB03-97	PL2SB04-97	PL2SB05-97	PL2SB05-97
Sample Matrix:	SO	SO	SO	SO	SO	SO
Sample Date:	12/10/1998	12/10/1998	12/10/1998	12/10/1998	12/10/1998	12/10/1998
Sample ID:	PL2SB02 0-2	PL2SB02 2-4	PL2SB03 2-4	PL2SB04 2-4	PL2SB05 10-12	PL2SB05 6-8
Depth (ft):	0-2	2-4	2-4	2-4	10-12	6-8
<b>PAHs (ug/kg)</b>						
PCB-1016(AROCHLOR1016)	2700U	58U	56U	57U	60U	58U
PCB-1221(AROCHLOR1221)	2700U	58U	56U	57U	60U	58U
PCB-1232(AROCHLOR1232)	2700U	58U	56U	57U	60U	58U
PCB-1242(AROCHLOR1242)	2700U	58U	56U	57U	60U	58U
PCB-1248(AROCHLOR1248)	6470	115	124	124	60U	58U
PCB-1254(AROCHLOR1254)	2700U	58U	56U	57U	60U	58U
PCB-1260(AROCHLOR1260)	2700U	58U	56U	57U	60U	58U



**Camp Dresser & McKee**  
**(August 2001)**

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## PCB Soil Samples

(Results from Camp Dresser & McKee, Inc., 2001)

Location:	offsite (outfall)	offsite (outfall)	offsite (outfall)	offsite (outfall)	offsite (outfall)	offsite (outfall)
Sample Matrix:	SE	SE	SE	SE	SE	SE
Sample Date:	08/03/2001	08/03/2001	08/03/2001	08/03/2001	08/03/2001	08/03/2001
Sample ID:	WNB-007-1	WNB-007-2	WNB-007-3	WNB-007-4	WNB-OF-9	WNB-OF-9D
Depth (ft):	0-0.125	0-0.125	0-0.125	0-0.125	0-0.125	0-0.125
<b>PCBs (ug/kg)</b>						
PCB-1016(AROCHLOR1016)	25U	25U	25U	25U	25U	25U
PCB-1221(AROCHLOR1221)	25U	25U	25U	25U	25U	25U
PCB-1232(AROCHLOR1232)	25U	25U	25U	25U	25U	25U
PCB-1242(AROCHLOR1242)	764	256	148	102	25U	25U
PCB-1248(AROCHLOR1248)	25U	25U	25U	25U	25U	25U
PCB-1254(AROCHLOR1254)	174	121	91	60	25U	25U
PCB-1260(AROCHLOR1260)	25U	25U	25U	25U	25U	25U

## PCB Soil Samples

(Results from Camp Dresser & McKee, Inc., 2001)

Location:	offsite (outfall)	offsite (channel)	offsite (channel)
Sample Matrix:	SE	SE	SE
Sample Date:	08/03/2001	08/03/2001	08/03/2001
Sample ID:	WNB-OF-10	WNB-DA-11	WNB-DA-12
Depth (ft):	0-0.125	0-0.125	0-0.125

### PCBs (ug/kg)

PCB-1016(AROCHLOR1016)	25U	25U	25U
PCB-1221(AROCHLOR1221)	25U	25U	25U
PCB-1232(AROCHLOR1232)	25U	25U	25U
PCB-1242(AROCHLOR1242)	25U	25U	77
PCB-1248(AROCHLOR1248)	25U	25U	25U
PCB-1254(AROCHLOR1254)	25U	25U	70
PCB-1260(AROCHLOR1260)	25U	25U	25U

**Tetra Tech EM, Inc**  
**(May 2002)**

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# VOC Results in Air

(Analytical results from Tetra Tech, 2002)

Location:	AA-01-02	AA-05-02	AA-07-02	AA-09-02	AA-11-02
Sample Matrix:	AA	AA	AA	AA	AA
Sample Date:	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002
Sample ID:	AIR-01	AIR-05	AIR-07	AIR-09	AIR-11
Depth (ft):	0-0	0-0	0-0	0-0	0-0
VOCs (ppb v/v)					
1,1,2,2-TETRACHLOROETHANE	0.37U	0.37U	0.37U	0.37U	0.37U
1,1,2-TRICHLOROETHANE	0.20U	0.20U	0.20U	0.20U	0.20U
1,2,4-TRIMETHYLBENZENE	0.69J	0.28U	0.94J	0.29J	0.28U
1,2-DICHLOROPROPANE	0.24U	0.24U	0.24U	0.24U	0.24U
1,3,5-TRIMETHYLBENZENE(MESITYLENE)	0.32U	0.32U	0.32U	0.32U	0.32U
BENZYLCHLORIDE	0.28U	0.28U	0.28U	0.28U	0.28U
BROMOMETHANE	0.24U	0.24U	0.24U	0.24U	0.24U
CARBONTETRACHLORIDE	0.24J	0.24U	0.24U	0.24U	0.24U
CHLOROBENZENE	0.20U	0.20U	0.20U	0.20U	0.20U
CHLOROFORM	0.24U	0.24U	0.24U	0.24U	0.24U
CHLOROMETHANE	1.0U	1.0U	1.0U	1.0U	1.0U
CIS-1,3-DICHLOROPROPENE	0.15U	0.15U	0.15U	0.15U	0.15U
DICHLORODIFLUOROMETHANE	1.0U	1.0U	1.0U	1.0U	1.0U
FREON 11	1.0U	1.2U	1.0U	1.6U	1.4U
FREON 113	0.27U	0.27U	0.27U	0.27U	0.27U
FREON 114	0.25U	0.25U	0.25U	0.25U	0.25U
METHYLENECHLORIDE	0.93J	0.25J	21.	0.33J	0.36J
STYRENE	0.22U	0.22U	0.22U	0.22U	0.22U
TRANS-1,3-DICHLOROPROPENE	0.17U	0.17U	0.17U	0.17U	0.17U

# VOC Results in Air

(Analytical results from Tetra Tech, 2002)

Location:	AA-01-02	AA-05-02	AA-07-02	AA-09-02	AA-11-02
Sample Matrix:	AA	AA	AA	AA	AA
Sample Date:	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002
Sample ID:	AIR-01	AIR-05	AIR-07	AIR-09	AIR-11
Depth (ft):	0-0	0-0	0-0	0-0	0-0
<b>CVOCs (ppb v/v)</b>					
1,1,1-TRICHLOROETHANE	29.	0.28J	0.32J	6.2	1.8
1,1-DICHLOROETHANE	0.25U	0.25U	0.25U	0.25U	0.25U
1,1-DICHLOROETHENE	0.25U	0.25U	0.25U		0.25U
1,2-DICHLOROETHANE	0.22U	0.22U	0.22U	0.25U	0.22U
CHLOROETHANE	0.33U	0.33U	0.33U	0.33U	0.33U
CIS-1,2-DICHLOROETHYLENE	0.26U	1.8	0.32J	0.38J	0.54J
TETRACHLOROETHYLENE(PCE)	0.18U	0.18U	0.18U	0.18U	0.19U
TRICHLOROETHYLENE(TCE)	0.18U	0.98J	0.59J	0.90J	3.3
VINYLCHLORIDE	0.28U	0.28U	0.28U	0.28U	0.28U
<b>BTEX (ppb v/v)</b>					
BENZENE	1.0U	1.0U	1.0U	1.0U	1.0U
ETHYLBENZENE	0.31J	0.25U	1.7	0.25U	0.25U
M,P-XYLENE(SUMOFISOMERS)	1.2	0.53U	5.9	0.53U	0.53U
O-XYLENE(1,2-DIMETHYLBENZENE)	0.37J	0.27U	1.4	0.27U	0.27U
TOLUENE	2.2U	1.0U	20.	1.0U	1.9U
<b>SVOC (ppb v/v)</b>					
1,2,4-TRICHLOROBENZENE	0.26U	0.26U	0.26U	0.26U	0.26U
1,2-DICHLOROBENZENE	0.24U	0.24U	0.24U	0.24U	0.24U
1,3-DICHLOROBENZENE	0.24U	0.24U	0.24U	0.24U	0.24U
1,4-DICHLOROBENZENE	0.29U	0.29U	0.29U	0.29U	0.29U
HEXACHLOROBUTADIENE	0.51U	0.51U	0.51U	0.51U	0.51U

# VOC Results in Soils

(Analytical results from Tetra Tech, 2002)

	Location:	SD-01-02	SD-02-02	SD-03-02	SS-01-02	SS-02-02
	Sample Matrix:	SE	SE	SE	SO	SO
	Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002
	Sample ID:	SD-01A	SD-02A	SD-03A	SS-01B	SS-02A
	Depth (ft):	0-1	0-1	0-1	0-1	0-1
VOCs (ug/kg wet)						
1,1,2,2-TETRACHLOROETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
1,1,2-TRICHLOROETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
1,2-DICHLOROPROPANE		5.00U	5.00U	5.00U	5.00U	5.00U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		25.0U	25.0U	43.6	25.0U	25.0U
BROMODICHLOROMETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
BROMOFORM		5.00U	5.00U	5.00U	5.00U	5.00U
BROMOMETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
CARBONTETRACHLORIDE		5.00U	5.00U	5.00U	5.00U	5.00U
CHLOROBENZENE		5.00U	5.00U	5.00U	5.00U	5.00U
CHLOROFORM		5.00U	5.00U	5.00U	5.00U	5.00U
CHLOROMETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
CIS-1,3-DICHLOROPROPENE		5.00U	5.00U	5.00U	5.00U	5.00U
DIBROMOCHLOROMETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
METHYLENECHLORIDE		5.00U	5.00U	5.00U	5.00U	5.00U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		5.00U	5.00U	5.00U	5.00U	5.00U
TRANS-1,3-DICHLOROPROPENE		5.00U	5.00U	5.00U	5.00U	5.00U
VINYLACETATE		10.0U	10.0U	10.0U	10.0U	10.0U



# VOC Results in Soils

(Analytical results from Tetra Tech, 2002)

	Location:	SD-01-02	SD-02-02	SD-03-02	SS-01-02	SS-02-02
	Sample Matrix:	SE	SE	SE	SO	SO
	Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002
	Sample ID:	SD-01A	SD-02A	SD-03A	SS-01B	SS-02A
	Depth (ft):	0-1	0-1	0-1	0-1	0-1
<b>CVOCs (ug/kg wet)</b>						
1,1,1-TRICHLOROETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
1,1-DICHLOROETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
1,1-DICHLOROETHENE		5.00U	5.00U	5.00U	5.00U	5.00U
1,2-DICHLOROETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
CHLOROETHANE		5.00U	5.00U	5.00U	5.00U	5.00U
CIS-1,2-DICHLOROETHYLENE		42.3	5.00U	5.00U	5.00U	5.00U
TETRACHLOROETHYLENE(PCE)		5.00U	5.00U	5.00U	5.00U	5.00U
TRANS-1,2-DICHLOROETHENE		5.00U	5.00U	5.00U	5.00U	5.00U
TRICHLOROETHYLENE(TCE)		5.00U	5.00U	5.00U	5.00U	5.00U
VINYLCHLORIDE		5.00U	5.00U	5.00U	5.00U	5.00U
<b>BTEX (ug/kg wet)</b>						
BENZENE		5.00U	5.00U	5.00U	5.00U	5.00U
ETHYLBENZENE		5.00U	5.00U	5.00U	5.00U	5.00U
TOLUENE		5.00U	5.00U	5.00U	5.00U	5.00U
XYLENES,TOTAL		10.0U	10.0U	10.0U	10.0U	10.0U

# PCBs and Metals Results in Soils

(Analytical results from Tetra Tech, 2002)

Location:	SD-01-02	SD-02-02	SD-03-02	SS-01-02	SS-02-02
Sample Matrix:	SE	SE	SE	SO	SO
Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002
Sample ID:	SD-01B	SD-02B	SD-03B	SS-01A	SS-02B
Depth (ft):	0-1	0-1	0-1	0-1	0-1

## PCBs (ug/kg wet)

PCB-1016(AROCHLOR1016)	25.0U	216U	25.0U	25.0U	25.0U
PCB-1221(AROCHLOR1221)	25.0U	216U	25.0U	25.0U	25.0U
PCB-1232(AROCHLOR1232)	25.0U	216U	25.0U	25.0U	25.0U
PCB-1242(AROCHLOR1242)	1890	216U	1360	25.0U	25.0U
PCB-1248(AROCHLOR1248)	25.0U	8530	25.0U	18400	2990
PCB-1254(AROCHLOR1254)	25.0U	216U	25.0U	25.0U	25.0U
PCB-1260(AROCHLOR1260)	25.0U	216U	25.0U	25.0U	25.0U

Location: SS-01-02  
Sample Matrix: SO  
Sample Date: 03/06/2002  
Sample ID: SS-01A  
Depth (ft): 0-1

## Metals (mg/kg wet)

ARSENIC	2.50U
BARIUM	25.0U
CADMIUM	1.88
CHROMIUM,TOTAL	697
LEAD	40.3
MERCURY	0.040U
SELENIUM	2.50U
SILVER	2.50U

**VOC Results in Water**  
 (Analytical results from Tetra Tech, 2002)

	Location:	W-06-02	W-09-02	W-11-02	W-12-02
	Sample Matrix:	WG	WG	WG	WG
	Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002
	Sample ID:	MW-06A	MW-09A	MW-11	MW-12
	Depth (ft):	15-27	13-28	22-27	10-25
VOCs (ug/L)					
1,1,2,2-TETRACHLOROETHANE		2.00U	2.00U	2.00U	2.00U
1,1,2-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U
1,2-DICHLOROPROPANE		2.00U	2.00U	2.00U	2.00U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U
ACETONE		10.0U	10.0U	10.0U	10.0U
BROMODICHLOROMETHANE		2.00U	2.00U	2.00U	2.00U
BROMOFORM		2.00U	2.00U	2.00U	2.00U
BROMOMETHANE		2.00U	2.00U	2.00U	2.00U
CARBONTETRACHLORIDE		2.00U	2.00U	2.00U	2.00U
CHLOROBENZENE		2.00U	2.00U	2.00U	2.00U
CHLOROFORM		2.00U	2.00U	2.00U	2.00U
CHLOROMETHANE		2.00U	2.00U	2.00U	2.00U
DIBROMOCHLOROMETHANE		2.00U	2.00U	2.00U	2.00U
METHYLENECHLORIDE		2.00U	2.00U	2.00U	2.00U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U
STYRENE		2.00U	2.00U	2.00U	2.00U
TOTAL,1,3-DICHLOROPROPENE (CISANDTRANS)		2.00U	2.00U	2.00U	2.00U
VINYLACETATE		2.00U	2.00U	2.00U	2.00U

**VOC Results in Water**  
 (Analytical results from Tetra Tech, 2002)

	Location:	W-06-02	W-09-02	W-11-02	W-12-02
	Sample Matrix:	WG	WG	WG	WG
	Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002
	Sample ID:	MW-06A	MW-09A	MW-11	MW-12
	Depth:	15-27	13-28	22-27	10-25
<b>CVOC (ug/L)</b>					
1,1,1-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U
1,1-DICHLOROETHANE		196U	18.6	2.00U	4.62
1,1-DICHLOROETHENE		12.3	18.0	2.00U	2.00U
1,2-DICHLOROETHANE		2.00U	2.00U	2.00U	2.00U
CHLOROETHANE		2.00U	2.00U	2.00U	2.00U
CIS-1,2-DICHLOROETHYLENE		6930	2080	2.00U	47.6
TETRACHLOROETHYLENE(PCE)		2.00U	2.00U	2.00U	2.00U
TRANS-1,2-DICHLOROETHENE		57.5	12.4	2.00U	2.00U
TRICHLOROETHYLENE(TCE)		2.00U	2.00U	2.00U	2.00U
VINYLCHLORIDE		146	383	2.00U	90.3
<b>BTEX (ug/L)</b>					
BENZENE		2.00U	2.00U	2.00U	2.00U
ETHYLBENZENE		2.00U	2.00U	2.00U	2.00U
TOLUENE		2.00U	2.00U	2.00U	2.00U
XYLENES,TOTAL		4.00U	4.00U	4.00U	4.00U

**PCB Results in Water****(Analytical results from Tetra Tech, 2002)**

	Location:	W-06-02	W-09-02	W-11-02	W-12-02
	Sample Matrix:	WG	WG	WG	WG
	Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002
	Sample ID:	MW-06A	MW-09A	MW-11	MW-12
	Depth (ft):	15-27	13-28	22-27	10-25
<b>PCBs (ug/L)</b>					
PCB-1016(AROCHLOR1016)		0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)		0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)		0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)		0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)		0.500U	0.500U	0.500U	0.500U
PCB-1254(AROCHLOR1254)		0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)		0.500U	0.500U	0.500U	0.500U

# PCB Wipe Results

(Analytical results from Tetra Tech, 2002)

Location:	WP-1-02	WP-2-02	WP-3-02	WP-4-02	WP-5-02	WP-6-02	WP-7-02	WP-8-02
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002
Sample ID:	Wipe-01	Wipe-02	Wipe-03	Wipe-04	Wipe-05	Wipe-06	Wipe-07	Wipe-08
Depth (ft):	0--1	0--1	0--1	0--1	0--1	0--1	0--1	0--1
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	1.0U	0.500U	0.500U	2.50U	0.500U	500U	10.0U	10.0U
PCB-1221(AROCHLOR1221)	1.0U	0.500U	0.500U	2.50U	0.500U	500U	10.0U	10.0U
PCB-1232(AROCHLOR1232)	1.0U	0.500U	0.500U	2.50U	0.500U	500U	10.0U	10.0U
PCB-1242(AROCHLOR1242)	1.0U	0.500U	0.500U	2.50U	0.500U	500U	10.0U	10.0U
PCB-1248(AROCHLOR1248)	<b>6.54</b>	<b>3.19</b>	<b>3.95</b>	<b>3.44</b>	<b>1.82</b>	<b>1130</b>	<b>111</b>	<b>46.2</b>
PCB-1254(AROCHLOR1254)	1.0U	0.500U	0.500U	2.50U	0.500U	500U	10.0U	10.0U
PCB-1260(AROCHLOR1260)	1.0U	0.500U	0.500U	2.50U	0.500U	500U	10.0U	10.0U

# PCB Wipe Results

(Analytical results from Tetra Tec)

Location:	WP-9-02	WP-10-02	WP-11-02	WP-12-02	WP-13-02	WP-14-02	WP-15-02	WP-16-02
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002
Sample ID:	Wipe-09	Wipe-10	Wipe-11	Wipe-12	Wipe-13	Wipe-14	Wipe-15	Wipe-16
Depth (ft):	0-1	0-1	0-1	0-1	0-1	0-2	0-2	0-1
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	100U	2500U	25.0U	25.0U	1.00U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	100U	2500U	25.0U	25.0U	1.00U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	100U	2500U	25.0U	25.0U	1.00U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	100U	2500U	25.0U	25.0U	1.00U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	567	9140	87.5	92.9	1.90	3.08	2.03	4.27
PCB-1254(AROCHLOR1254)	100U	2500U	25.0U	25.0U	1.00U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	100U	2500U	25.0U	25.0U	1.00U	0.500U	0.500U	0.500U

**PCB Wipe Results**  
(Analytical results from Tetra Tec)

Location:	WP-17-02	WP-18-02	WP-19-02	WP-20-02	WP-21-02	WP-22-02	WP-23-02	WP-24-02
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002
Sample ID:	Wipe-17	Wipe-18	Wipe-19	Wipe-20	Wipe-21	Wipe-22	Wipe-23	Wipe-24
Depth (ft):	0--1	0--1	0--2	0--1	0--1	0--1	0--1	0--1
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	5.00U	0.500U	0.500U	5.00U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	5.00U	0.500U	0.500U	5.00U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	5.00U	0.500U	0.500U	5.00U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	5.00U	0.500U	0.500U	5.00U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	<b>46.3</b>	<b>1.81</b>	<b>2.51</b>	<b>19.1</b>	<b>82.0</b>	<b>361</b>	<b>134</b>	<b>86.7</b>
PCB-1254(AROCHLOR1254)	5.00U	0.500U	0.500U	5.00U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	5.00U	0.500U	0.500U	5.00U	0.500U	0.500U	0.500U	0.500U



# PCB Wipe Results

(Analytical results from Tetra Tec)

Location:	WP-25-02	WP-26-02	WP-27-02	WP-28-02	WP-29-02	WP-30-02	WP-31-02	WP-32-02
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002
Sample ID:	Wipe-25	Wipe-26	Wipe-27	Wipe-28	Wipe-29	Wipe-30	Wipe-31	Wipe-32A
Depth (ft):	0-3	0-1	0-1	0-1	0-1	0-4	0-4	0-4
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	22.8	1190	22.1	74.5	3.40J	12.1	11.1	16.7
PCB-1254(AROCHLOR1254)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U

# PCB Wipe Results

(Analytical results from Tetra Tec)

Location:	WP-33-02	WP-34-02	WP-35-02	WP-36-02	WP-37-02	WP-38-02	WP-39-02	WP-40-02
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/05/2002	03/06/2002
Sample ID:	Wipe-33	Wipe-34A	Wipe-35A	Wipe-36A	Wipe-37A	Wipe-38A	Wipe-39A	Wipe-40A
Depth (ft):	0--1	0--4	0--1	0--4	0--1	0--4	0--1	0--4
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	65.0	18.1	12.7	5.70	38.8	19.2	21.8	10.3
PCB-1254(AROCHLOR1254)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U

# PCB Wipe Results

(Analytical results from Tetra Tec)

Location:	WP-41-02	WP-42-02	WP-43-02	WP-44-02	WP-45-02	WP-46-02	WP-47-02	WP-48-02
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	03/06/2002	03/03/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002
Sample ID:	Wipe-41A	Wipe-42A	Wipe-43A	Wipe-44A	Wipe-45A	Wipe-46A	Wipe-47A	Wipe-48
Depth (ft):	0-1	0-4	0-1	0-1	0-4	0-1	0-4	0-1
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	17.8	16.2	9.43	23.1	36.9	29.0	25.3	16.5
PCB-1254(AROCHLOR1254)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U

# PCB Wipe Results

(Analytical results from Tetra Tec)

Location:	WP-49-02	WP-50-02	WP-51-02	WP-52-02	WP-53-02	WP-54-02	WP-55-02	WP-56-02
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/03/2002	03/06/2002	03/06/2002
Sample ID:	Wipe-49A	Wipe-50A	Wipe-51	Wipe-52	Wipe-53A	Wipe-54	Wipe-55	Wipe-56
Depth (ft):	0--4	0--1	0--1	0--4	0--1	0--4	0--1	0--5
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	11.3	18.1	0.753	3.99	7.84	1.57	0.500U	2.81
PCB-1254(AROCHLOR1254)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U

**PCB Wipe Results**  
(Analytical results from Tetra Tec)

<b>Location:</b>	<b>WP-57-02</b>	<b>WP-58-02</b>	<b>WP-59-02</b>	<b>WP-60-02</b>	<b>WP-61-02</b>	<b>WP-62-02</b>	<b>WP-63-02</b>	<b>WP-64-02</b>
<b>Sample Matrix:</b>	<b>SW</b>	<b>SW</b>	<b>SW</b>	<b>SW</b>	<b>SW</b>	<b>SW</b>	<b>SW</b>	<b>SW</b>
<b>Sample Date:</b>	<b>03/06/2002</b>	<b>03/06/2002</b>	<b>03/06/2002</b>	<b>03/06/2002</b>	<b>03/06/2002</b>	<b>03/06/2002</b>	<b>03/06/2002</b>	<b>03/06/2002</b>
<b>Sample ID:</b>	<b>Wipe-57</b>	<b>Wipe-58</b>	<b>Wipe-59</b>	<b>Wipe-60</b>	<b>Wipe-61A</b>	<b>Wipe-62</b>	<b>Wipe-63A</b>	<b>Wipe-64</b>
<b>Depth (ft):</b>	<b>0--4</b>	<b>0--1</b>	<b>0--4</b>	<b>0--1</b>	<b>0--1</b>	<b>0--1</b>	<b>0--1</b>	<b>0--4</b>
<b>PCBs (ug/wipe)</b>								
PCB-1016(AROCHLOR1016)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	<b>1.96</b>	<b>1.83</b>	<b>2.57</b>	<b>4.52</b>	<b>6.27</b>	<b>0.500U</b>	<b>9.60</b>	<b>0.500U</b>
PCB-1254(AROCHLOR1254)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U

# PCB Wipe Results

(Analytical results from Tetra Tec)

Location:	WP-65-02	WP-66-02	WP-67-02	WP-68-02	WP-69-02	WP-70-02
Sample Matrix:	SW	SW	SW	SW	SW	SW
Sample Date:	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002	03/06/2002
Sample ID:	Wipe-65	Wipe-66	Wipe-67A	Wipe-68	Wipe-69	Wipe-70A
Depth (ft):	0--1	0--3	0--1	0--1	0--1	0--1
<b>PCBs (ug/wipe)</b>						
PCB-1016(AROCHLOR1016)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	1.89	2.38	7.54	4.13	3.04	10.6
PCB-1254(AROCHLOR1254)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U

**Tetra Tech EM, Inc**  
**(December 2003)**

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**PCB Results in Air****(Results from Tetra Tech, 2003)**

<b>Location:</b>	<b>AA-201-03</b>	<b>AA-202-03</b>	<b>AA-203-03</b>	<b>AA-204-03</b>
<b>Sample Matrix:</b>	<b>AA</b>	<b>AA</b>	<b>AA</b>	<b>AA</b>
<b>Sample Date:</b>	<b>07/07/2003</b>	<b>07/07/2003</b>	<b>07/07/2003</b>	<b>07/07/2003</b>
<b>Sample ID:</b>	<b>Air-201</b>	<b>Air-202</b>	<b>Air-203</b>	<b>Air-204</b>
<b>Depth (ft):</b>	<b>0-0</b>	<b>0-0</b>	<b>0-0</b>	<b>0-0</b>

**PCBs (ug/m<sup>3</sup>)**

PCB-1016(AROCHLOR1016)	0.44U	0.5U	0.45U	0.47U
PCB-1221(AROCHLOR1221)	0.88U	1U	0.91U	0.94U
PCB-1232(AROCHLOR1232)	0.44U	0.5U	0.45U	0.47U
PCB-1242(AROCHLOR1242)	<b>18</b>	<b>15</b>	<b>5.4</b>	<b>4.2</b>
PCB-1248(AROCHLOR1248)	0.44U	0.5U	0.45U	0.47U
PCB-1254(AROCHLOR1254)	0.44U	0.5U	0.45U	0.47U
PCB-1260(AROCHLOR1260)	0.44U	0.5U	0.45U	0.47U



**VOC Results in Soils**  
(Results from Tetra Tech, 2003)

	Location:	GP-2-03	GP-3-03	GP-4-03	GP-5-03	GP-6-03	GP-7-03	GP-8-03
	Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
	Sample Date:	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003
	Sample ID:	GP-2 3-4	GP-3 3-4	GP-4 3-4	GP-5 3-4	GP-6 3-4	GP-7 3	GP-8 24
	Depth (ft):	3-4	3-4	3-4	3-4	3-4	3-3	24-24
<b>VOCs (ug/kg)</b>								
1,1,2,2-TETRACHLOROETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
1,1,2-TRICHLOROETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
1,2-DICHLOROPROPANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
2-HEXANONE		12.2U	10.4U	10.2U	10.9U	12.9U	11.6U	12.8U
ACETONE		30.5U	58.2	25.5U	27.4U	32.2U	29.1U	31.9U
BROMODICHLOROMETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
BROMOFORM		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
BROMOMETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
CARBONTETRACHLORIDE		6.10U	5.20U	5.10U	5.47U	6.55U	5.81U	6.38U
CHLOROBENZENE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
CHLOROFORM		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
CHLOROMETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
DIBROMOCHLOROMETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
METHYLENECHLORIDE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		12.2U	10.4U	10.2U	10.9U	12.9U	11.6	12.8U
STYRENE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
TOTAL,1,3-DICHLOROPROPENE(CISANDTRANS)		3.66U	3.12U	3.06U	3.28U	3.86U	3.49U	3.83U
VINYLACETATE		12.2U	10.4U	10.2U	10.9U	12.9U	11.6U	12.8U

**VOC Results in Soils**  
(Results from Tetra Tech, 2003)

	Location:	GP-8-03	GP-9-03	GP-12-03	GP-14-03	GP-15-03	GP-15-03
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	06/04/2003	06/04/2003	06/05/2003	06/05/2003	06/05/2003	06/05/2003
	Sample ID:	GP-8 3-4	GP-9 24	GP-12 26-28	GP-14 5	GP-15 6	Gp-15 30
	Depth (ft):	3-4	24-24	26-28	5-5	6-6	30-30
<b>VOCs (ug/kg)</b>							
1,1,2,2-TETRACHLOROETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
1,1,2-TRICHLOROETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
1,2-DICHLOROPROPANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
2-HEXANONE		9.31U	11.9U	12.4U	11.1U	10.8U	12.3U
ACETONE		23.3U	29.8U	30.9U	27.9U	27.0U	30.9U
BROMODICHLOROMETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
BROMOFORM		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
BROMOMETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
CARBONTETRACHLORIDE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
CHLOROBENZENE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
CHLOROFORM		4.65U	5.96U	6.18U	5.57U	10.2	6.17U
CHLOROMETHANE		4.65U	6.68	6.18U	5.57U	5.41U	6.17U
DIBROMOCHLOROMETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
METHYLENECHLORIDE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		9.31U	11.9U	12.4U	11.1U	10.8U	12.3U
STYRENE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
TOTAL,1,3-DICHLOROPROPENE(CISANDTRANS)		2.79U	3.58U	3.71U	3.34U	3.24U	3.70U
VINYLACETATE		9.31U	11.9U	12.4U	11.1U	10.8U	12.3U

**VOC Results in Soils**  
(Results from Tetra Tech, 2003)

	Location:	GP-2-03	GP-3-03	GP-4-03	GP-5-03	GP-6-03	GP-7-03	GP-8-03
	Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
	Sample Date:	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003
	Sample ID:	GP-2 3-4	GP-3 3-4	GP-4 3-4	GP-5 3-4	GP-6 3-4	GP-7 3	GP-8 24
	Depth (ft):	3-4	3-4	3-4	3-4	3-4	3-3	24-24
<b>CVOCs (ug/kg)</b>								
1,1,1-TRICHLOROETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
1,1-DICHLOROETHANE		6.10U	5.20U	44.0	5.54	6.44U	5.81U	7.64
1,1-DICHLOROETHENE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	119
1,2-DICHLOROETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
CHLOROETHANE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
CIS-1,2-DICHLOROETHYLENE		6.10U	14.6	794	51.8	6.44U	5.81U	35000
TETRACHLOROETHYLENE(PCE)		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	10.6
TRANS-1,2-DICHLOROETHENE		6.10U	5.20U	18.5	5.47U	6.44U	5.81U	236
TRICHLOROETHYLENE(TCE)		6.10U	5.20U	7.10	5.47U	6.44U	5.81U	268000
VINYLCHLORIDE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	435
<b>BTEX (ug/kg)</b>								
BENZENE		8.74	5.20U	5.31	7.61	6.44U	5.81U	11.0
ETHYLBENZENE		6.10U	5.20U	5.10U	5.47U	6.44U	5.81U	6.38U
TOLUENE		17.0	5.20U	10.4	14.5	7.35	11.6	12.5
XYLENES,TOTAL		12.2U	10.4U	10.2U	10.9U	12.9U	11.6U	12.9

**VOC Results in Soils**  
(Results from Tetra Tech, 2003)

	Location:	GP-8-03	GP-9-03	GP-12-03	GP-14-03	GP-15-03	GP-15-03
	Sample Matrix:	SO	SO	SO	SO	SO	SO
	Sample Date:	06/04/2003	06/04/2003	06/05/2003	06/05/2003	06/05/2003	06/05/2003
	Sample ID:	GP-8 3-4	GP-9 24	GP-12 26-28	GP-14 5	GP-15 6	GP-15 30
	Depth (ft):	3-4	24-24	26-28	5-5	6-6	30-30
<b>CVOCs (ug/kg)</b>							
1,1,1-TRICHLOROETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
1,1-DICHLOROETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
1,1-DICHLOROETHENE		4.65U	20.6	6.18U	5.57U	20.1	6.17U
1,2-DICHLOROETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
CHLOROETHANE		4.65U	5.96U	6.18U	5.57U	5.41U	6.17U
CIS-1,2-DICHLOROETHYLENE		29.6	3820	6.18U	33.8	90500	6.17U
TETRACHLOROETHYLENE(PCE)		4.65U	5.96U	6.18U	5.57U	17.7	6.17U
TRANS-1,2-DICHLOROETHENE		4.65U	5.96U	6.18U	22.2	57.7	6.17U
TRICHLOROETHYLENE(TCE)		59.7	80800	6.18U	57.7	248000	6.17U
VINYLCHLORIDE		4.65U	7.53	6.18U	5.57U	5.41U	6.17U
<b>BTEX (ug/kg)</b>							
BENZENE		5.90	12.3	8.53	5.57U	5.41U	11.2
ETHYLBENZENE		8.79	5.96U	6.18U	5.57U	5.41U	6.17U
TOLUENE		15.8	18.2	23.0	10.1	5.41U	19.2
XYLENES,TOTAL		56.3	11.9U	12.4U	11.1U	10.8U	12.3U

**PCBs and Metals Results in Soils**  
(Results from Tetra Tech, 2003)

**PCBs (ug/kg)**

	Location:	GP-5-03	GP-7-03	GP-7-03	GP-8-03	GP-10-03	GP-10-03	GP-11-03
	Sample Matrix:	SO	SO	SO	SO	SO	SO	SO
	Sample Date:	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003	06/04/2003
	Sample ID:	GP-5 3-4B	GP-7 3B	GP-7 3C	GP-8 3-4B	GP-10 3	GP-10 3B	GP-11 3
	Depth (ft):	3-4	3-3	3-3	3-4	3-3	3-3	3-3
PCB-1016(AROCHLOR1016)		29.0U	29.0U	28.7U	27.4U	29.1U	29.1U	75.9U
PCB-1221(AROCHLOR1221)		29.0U	29.0U	28.7U	27.4U	29.1U	29.1U	75.9U
PCB-1232(AROCHLOR1232)		29.0U	29.0U	28.7U	27.4U	29.1U	29.1U	75.9U
PCB-1242(AROCHLOR1242)		29.0U	29.0U	28.7U	27.4U	29.1U	29.1U	75.9U
PCB-1248(AROCHLOR1248)		29.0U	119	28.7U	604	29.1U	29.1U	7170
PCB-1254(AROCHLOR1254)		29.0U	29.0U	28.7U	27.4	29.1U	29.1U	75.9U
PCB-1260(AROCHLOR1260)		29.0U	29.0U	28.7U	27.4	29.1U	29.1U	75.9U

**Metals (mg/kg)**

	Location:	GP-13-03
	Sample Matrix:	SO
	Sample Date:	06/05/2003
	Sample ID:	GP-13 1 B
	Depth (ft):	1-1
ARSENIC		3.5
BARIUM		26.5U
CADMIUM		0.53U
CALCIUM		46300
CHROMIUM,TOTAL		8.05
IRON		7760
LEAD		11.2
MAGNESIUM		23300
MERCURY		0.424U
POTASSIUM		393
SELENIUM		2.65U
SILVER		2.65U
SODIUM		199U

**VOC Results in Water**  
(Results from Tetra Tech, 2003)

	Location:	GP-2-03	GP-4-03	GP-5-03	GP-6-03	GP-7-03	GP-8-03	GP-12-03
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	06/09/2003	06/09/2003	06/09/2003	06/09/2003	06/09/2003	06/09/2003	06/06/2003
	Sample ID:	GP-2	GP-4	GP-5	GP-6	GP-7	GP-8A	GP-12-1
	Depth (ft):	3-4	3-4	3-4	3-4	0-3	3-4	26-28
VOCs (ug/L)								
1,1,2,2-TETRACHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,1,2-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,2-DICHLOROPROPANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		67.7	36.6	42.8	10.0U	11.2	10.0U	10.0U
BROMODICHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
BROMOFORM		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
BROMOMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CARBONTETRACHLORIDE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROBENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROFORM		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
DIBROMOCHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
METHYLENECHLORIDE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TOTAL,1,3-DICHLOROPROPENE(CISANDTRANS)		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
VINYLACETATE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U

**VOC Results in Water**  
(Results from Tetra Tech, 2003)

	Location:	GP-2-03	GP-4-03	GP-5-03	GP-6-03	GP-7-03	GP-8-03	GP-12-03
	Sample Matrix:	WG	WG	WG	WG	WG	WG	WG
	Sample Date:	06/09/2003	06/09/2003	06/09/2003	06/09/2003	06/09/2003	06/09/2003	06/06/2003
	Sample ID:	GP-2	GP-4	GP-5	GP-6	GP-7	GP-8A	GP-12-1
	Depth (ft):	3-4	3-4	3-4	3-4	0-3	3-4	26-28
<b>CVOCs (ug/L)</b>								
1,1,1-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,1-DICHLOROETHANE		2.00U	163	2.00U	2.00U	2.00U	7.75	2.00U
1,1-DICHLOROETHENE		2.00U	7.92	2.00U	2.00U	2.00U	59.3	2.00U
1,2-DICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROETHANE		2.00U	2.00U	5.10	2.00U	2.00U	2.00U	2.00U
CIS-1,2-DICHLOROETHYLENE		2.00U	1660	9.14	4.03	2.00U	16900	199
TETRACHLOROETHYLENE(PCE)		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TRANS-1,2-DICHLOROETHENE		2.00U	27.2	2.00U	2.00U	2.00U	66.6	2.00U
TRICHLOROETHYLENE(TCE)		2.00U	5.98	2.00U	2.00U	2.00U	2940	3.12
VINYLCHLORIDE		2.00U	103	10.4	2.00U	2.00U	2.00U	801
<b>BTEX (ug/L)</b>								
BENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
ETHYLBENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TOLUENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.77	2.00U
XYLENES,TOTAL		4.00U	4.00U	4.00U	4.00U	2.00U	4.00U	4.00U

**VOC Results in Water**  
(Results from Tetra Tech, 2003)

	Location:	GP-14-03	GP-15-03	MW-13-03	MW-14-03	MW-14-03	MW-15-03
	Sample Matrix:	WG	WG	WG	WG	WG	WG
	Sample Date:	06/05/2003	06/09/2003	06/06/2003	06/06/2003	06/06/2003	06/05/2003
	Sample ID:	GP-14-1	GP-15	MW-13-1	MW-14D-1	MW-14S-1	MW-15D-1
	Depth (ft):	0-5	6-30	-	25-27	6-8	25-27
<b>VOCs (ug/L)</b>							
1,1,2,2-TETRACHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,1,2-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,2-DICHLOROPROPANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		12.4	10.0U	10.0U	10.0U	20.1	10.0U
BROMODICHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
BROMOFORM		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
BROMOMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CARBONTETRACHLORIDE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROBENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROFORM		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
DIBROMOCHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
METHYLENECHLORIDE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TOTAL,1,3-DICHLOROPROPENE(CISANDTRANS)		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
VINYLACETATE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U



**VOC Results in Water**  
(Results from Tetra Tech, 2003)

	Location:	GP-14-03	GP-15-03	MW-13-03	MW-14-03	MW-14-03	MW-15-03
	Sample Matrix:	WG	WG	WG	WG	WG	WG
	Sample Date:	06/05/2003	06/09/2003	06/06/2003	06/06/2003	06/06/2003	06/05/2003
	Sample ID:	GP-14-1	GP-15	MW-13-1	MW-14D-1	MW-14S-1	MW-15D-1
	Depth (ft):	0-5	6-30	-	25-27	6-8	25-27
<b>CVOCs (ug/L)</b>							
1,1,1-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,1-DICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,1-DICHLOROETHENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,2-DICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CIS-1,2-DICHLOROETHYLENE		4.47	185	2.00U	2.00U	2.00U	2.00U
TETRACHLOROETHYLENE(PCE)		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TRANS-1,2-DICHLOROETHENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TRICHLOROETHYLENE(TCE)		2.00U	137	2.00U	2.00U	2.00U	2.00U
VINYLCHLORIDE		2.00U	3.56	2.00U	2.00U	2.00U	2.00U
<b>BTEX (ug/L)</b>							
BENZENE		2.00U	2.00U	2.00U	32.0	2.00U	2.00U
ETHYLBENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TOLUENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
XYLENES,TOTAL		4.00U	4.00U	4.00U	4.00U	4.00U	4.00U

**VOC Results in Water**  
(Results from Tetra Tech, 2003)

	Location:	MW-15-03	MW-T101-03	MW-T104-03	MW-T105-03	MW-T106-03	MW-T107-03
	Sample Matrix:	WG	WG	WG	WG	WG	WG
	Sample Date:	06/05/2003	06/05/2003	06/06/2003	06/06/2003	06/06/2003	06/09/2003
	Sample ID:	MW-15S-1	MW-T101-1	MW-T104-1	MW-T105-1	MW-T106-1	MW-T107
	Depth (ft):	6-8	2-12	25-27	25-27	25-27	25-27
<b>VOCs (ug/L)</b>							
1,1,2,2-TETRACHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,1,2-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,2-DICHLOROPROPANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
2-HEXANONE		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
ACETONE		10.0U	10.0U	10.0U	16.8	10.0U	58.0
BROMODICHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
BROMOFORM		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
BROMOMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CARBONTETRACHLORIDE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROBENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROFORM		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
DIBROMOCHLOROMETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
METHYLENECHLORIDE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
METHYLISOBUTYLKETONE(4-METHYL-2-PENTANONE)		10.0U	10.0U	10.0U	10.0U	10.0U	10.0U
STYRENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TOTAL,1,3-DICHLOROPROPENE(CISANDTRANS)		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
VINYLCETATE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U

**VOC Results in Water**  
(Results from Tetra Tech, 2003)

	Location:	MW-15-03	MW-T101-03	MW-T104-03	MW-T105-03	MW-T106-03	MW-T107-03
	Sample Matrix:	WG	WG	WG	WG	WG	WG
	Sample Date:	06/05/2003	06/05/2003	06/06/2003	06/06/2003	06/06/2003	06/09/2003
	Sample ID:	MW-15S-1	MW-T101-1	MW-T104-1	MW-T105-1	MW-T106-1	MW-T107
	Depth (ft):	6-8	2-12	25-27	25-27	25-27	25-27
<b>CVOCs (ug/L)</b>							
1,1,1-TRICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,1-DICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.03
1,1-DICHLOROETHENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
1,2-DICHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CHLOROETHANE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
CIS-1,2-DICHLOROETHYLENE		23.2	2.00U	2.05	2.00U	2.00U	2.00U
TETRACHLOROETHYLENE(PCE)		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TRANS-1,2-DICHLOROETHENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TRICHLOROETHYLENE(TCE)		6.78	2.00U	2.00U	2.00U	16.0	2.00U
VINYLCHLORIDE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
<b>BTEX (ug/L)</b>							
BENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
ETHYLBENZENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
TOLUENE		2.00U	2.00U	2.00U	2.00U	2.00U	2.00U
XYLENES,TOTAL		4.00U	4.00U	4.00U	4.00U	4.00U	4.00U

## Wipe Samples

(Results from Tetra Tech, 2003)

Location:	WP-401-03	WP-402-03	WP-403-03	WP-404-03	WP-405-03	WP-406-03	WP-407-03	WP-408-03
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW	SW
Sample Date:	05/21/2003	05/21/2003	05/21/2003	06/09/2003	06/09/2003	06/09/2003	06/16/2003	06/16/2003
Sample ID:	WP-401 Wipe	WP-402 Wipe	WP-403 Wipe	WP-404	WP-405	WP-406A	WP-407	WP-408A
Depth (ft):	0-1	0-1	0-1	0-1	0-1	0-1	0-1	0-1

### PCBs (ug/wipe)

PCB-1016(AROCHLOR1016)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	13.3	1.23	15.0	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	0.500U	0.500U	0.500U	11.0	6.76	18.0	148	297
PCB-1254(AROCHLOR1254)	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	0.500U	0.5600U	0.500U	0.500U	0.500U	0.500U	0.500U	0.500U

# Wipe Samples

(Results from Tetra Tech, 2003)

Location:	WP-409-03	WP-410-03	WP-411-03	WP-412-03	WP-413-03	WP-414-03	WP-415-03
Sample Matrix:	SW	SW	SW	SW	SW	SW	SW
Sample Date:	06/18/2003	06/18/2003	06/20/2003	06/20/2003	06/26/2003	06/26/2003	06/26/2003
Sample ID:	WP-409	WP-410	WP-411A	WP-412A	WP-413	WP-414	WP-415
Depth (ft):	0-1	0-1	0-1	0-1	0-1	0-1	0-1

## PCBs (ug/wipe)

PCB-1016(AROCHLOR1016)	500U	50.0U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1221(AROCHLOR1221)	500U	50.0U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1232(AROCHLOR1232)	500U	50.0U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1242(AROCHLOR1242)	500U	50.0U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1248(AROCHLOR1248)	2760	261	119	40.2	1.26	14.7	6.64
PCB-1254(AROCHLOR1254)	500U	50.0U	0.500U	0.500U	0.500U	0.500U	0.500U
PCB-1260(AROCHLOR1260)	1490	50.0U	0.500U	0.500U	0.500U	0.500U	0.500U

**Appendix B**  
**Field Operating Procedures**

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## APPENDIX B

# Field Operating Procedures

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The following field operating procedures to perform the field investigation at the OMC Plant 2 site are attached:

FOP Number	Title
FOP-01	PCB Wipe Sample Collection
FOP-02	Bulk Concrete Sample Collection
FOP-03	Direct Push Soil Sample Collection
FOP-04	Membrane Interface Probe Sample Collection
FOP-05	Hollow-Stem Auger Drilling and Soil Sample Collection
FOP-06	Monitoring Well and Soil Boring Abandonment
FOP-07	Volatile Organic Compound Soil Sampling
FOP-08	Soil Oxidant Demand Sample Collection
FOP-09	Monitoring Well Installation and Development
FOP-10	Groundwater Level Measurement
FOP-11	Low-Flow Groundwater Sampling Procedures
FOP-12	Groundwater Sample Filtration Procedures
FOP-13	In Situ Hydraulic Testing
FOP-14	Sample Handling, Packaging, and Shipping
FOP-15	Field Logbook
FOP-16	Documentation / Chain-of-Custody Procedure
FOP-17	Decontamination of Drilling Rigs and Equipment
FOP-18	Decontamination of Personnel and Equipment
FOP-19	Equipment Calibration
FOP-20	Indoor Air Sample Collection
FOP-21	Soil Gas Sample Collection Using Summa™ Canisters



# PCB Wipe Sample Collection

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## Purpose

The purpose of this FOP is to delineate protocols for the collection of wipe samples of potentially contaminated building materials for the analysis of PCBs.

## Scope

The method described for PCB wipe sample collection is applicable for wipe sampling from building floors, piping, and walls.

## Equipment and Materials

- 10-centimeter-square to mark the area to be sampled
- Sterile cotton fiber pads (3-inch-square or other standard size provided by the laboratory)
- 4-ounce clear glass jars with Teflon® caps provided by the laboratory
- Measuring tape
- Pencil
- Field logbook and camera
- Shipping containers (coolers and ice)
- Sample tags, labels, and chain-of-custody form
- Decontamination supplies
- Protective equipment, including Nitrile gloves, safety glasses, and dust mask (Note: See HSP for specific PPE required for the sampling activities.)

## Procedures and Guidelines

1. Visually inspect building walls, piping, and floors for staining or other evidence that residual contamination exists in the building materials.
2. Place the stainless steel template over the area of potential contamination and trace with a pencil. (Do not use a permanent marker because of the possible sample contamination from the constituents in the ink.)
3. Remove cotton pad from sample jar and soak with the appropriate preservative. Fully saturate the pad and then squeeze any excess free liquid. Collect the excess liquid for proper disposal.
4. Wipe the area designated for sampling as follows:
  - a. Wipe the entire area horizontally starting from the left and moving toward the right.
  - b. Then, wipe the entire area vertically starting from the top and moving toward the bottom.

- c. In both cases, apply moderate pressure and ensure the systematic coverage of the entire area.
  - d. Use the same number of wipe strokes for each area.
  - e. Place the pad in the sample jar; close the jar tightly, label, and place in a cooler on ice and away from direct sunlight.
5. Record the location of the wipe sample from known points in the building to the nearest 0.01 foot in the field logbook.
  6. Fill in required information on labels, tags, and chain-of-custody forms.
  7. Decontaminate template and change sampling gloves between each area.

### **Duplicate (Co-located) Sample Collection**

Because of the heterogeneous nature of the matrix, a true “duplicate” sample cannot be collected. A co-located sample will be collected to aid in the assessment of field sampling procedure precision.

A co-located sample will consist of a sample collected adjacent to the original sample location. The specific location for the co-located sample will be determined by selecting an area that has similar visual characteristics to the original sample. The same sampling procedures, described above, will be used to collect the co-located sample.

Do this at the first sampling location by designating the area from which the duplicate will be collected to the right and immediately adjacent to the area where the wipe sample is collected. First, collect the sample for analysis, and then the duplicate.

Note: The co-located sample will be assigned a unique sample identifier and CLP sample number (i.e., different from that of the original sample).

### **Attachments**

None.

### **Key Checks and Items**

Ensure the consistent application of the procedure between sampling locations (e.g., coverage of the area to be sampled and pressure applied during sampling).

# Bulk Concrete Sample Collection

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## Purpose

The purpose of this FOP is to delineate protocols for the collection of chip samples of potentially contaminated building materials for the analysis of PCBs and TAL metals.

## Scope

The method described for bulk concrete sampling is applicable for concrete sampling from building floors and walls. Specific equipment and responsibilities of concrete coring contractors are described in contracting documentation.

## Equipment and Materials

- Heavy-duty, floor-mounted, diamond core drill and associated core drill bits
- Power source for core drill (120 V ac, 25–60 Hz, 20 A) and associated extension cord to reach core drill rig
- Water source for core drill cooling (optional), and associated hose to connect water spigot to core drill rig
- Large hammer
- Large concrete/masonry chisel
- Heavy plastic bags
- Stainless steel mixing bowls
- Stainless steel trowels
- Protective eye ware (safety glasses)
- Latex gloves
- Dust masks
- Ear plugs
- Sampling jars (supplied by laboratory)

Note: See HSP for specific PPE required for the sampling activities.

## Procedures and Guidelines

### Core Drilling

Core drilling will be performed using a heavy-duty, floor-mounted, core drill. Depending on the availability, a diamond core drill bit anywhere from 2 to 4 inches in diameter will be used to collect the sample.

Choose a location to core that is level, away from any utilities that might run through the slab, and accessible to power. Extra extension cords can be used to facilitate this. If the site is not level, the core drill rig will not be stable and drilling will be difficult and unsafe. It is also recommended that a location be accessible to a water source (water spigot); however, this is not necessary. Most core drills have a garden hose style screw fitting that will allow water to be discharged over the core bit during drilling in order to lubricate and cool it. Drilling can be performed dry; however, this will simply shorten the life of the core bit. Additionally, when coring through a slab that is not on grade, be sure to secure the area on the floor below where the sample core and cuttings might fall.

Once a suitable location is chosen, install the core bit per the manufacturer's instructions, then connect the rig to the power source and water source, if available. At this time, it is recommended that safety glasses, a dust mask, and earplugs are worn. Turn on the drill rig and lower the core bit to the concrete surface using the rack and pinion feed mechanism. Constant pressure must be applied to the feed mechanism during drilling in order to advance the core bit. If available, periodically discharge some water on the bit. This water will also serve to keep the dust down. At no time should the drill rig be left unattended while it is operating.

Typical core drill bits will allow a cut of 12 to 13 inches deep. If the slab that is being sampled is within this thickness, only one core run will be required to obtain a full profile. If the slab is greater than 12 or 13 inches, the first core run will need to be removed, and second run will be needed in the same core hole in order to fully penetrate the slab. In order to determine the depth of the core bit, monitor its vertical displacement with a ruler during drilling operations.

If the slab is penetrated with a single core run, the core sample will be withdrawn within the core bit. Lightly tapping on the core bit with a hammer will free the core sample if it does not slide out on its own. If two core runs are required to penetrate the slab, the first core sample will remain in the hole while the core bit is withdrawn. In order to free the core sample, insert a chisel into the annulus cut by the core bit and advance it with a hammer. Note that the width of the chisel might be slightly greater than the width of the annulus. When the core sample breaks free, remove it from the hole. Reinsert the core bit in the hole and proceed with the second run. It is critical that, for a given location, complete penetration of the slab is achieved in order to collect a true composite sample of the concrete/masonry profile.

It should be noted that several slab penetrations may be necessary in order to collect a sufficient amount of concrete/masonry to satisfy the analytical laboratory's sample quantity requirements. Sample preparation and rules of thumb for collection volume are discussed in the following section.

## Sampling

Once the core run samples are collected from a given location, remove all excess soil from beneath slab that might be present on samples taken from slabs on grade. Next, the core samples must be pulverized into sand-sized grains using a hammer. Place the sample into a plastic bag before pulverizing with the hammer. The plastic bag will help to contain the sample. Once a core sample is pulverized, empty the sample into a large mixing bowl and thoroughly mix it with a trowel in order to get a true homogeneous, composite sample. Remove any pieces of rebar that may have been included in the core sample. A good rule of thumb to follow when determining how many slab penetrations to perform at a given location is as follows: 3 to 4 inches of a 2-inch-diameter core sample will fill a single 4-ounce jar when pulverized to a sand consistency. Using a trowel, fill the required number of sample containers with the pulverized material.

Depending on the analytical laboratory being used, a solid core sample may be accepted. The core is typically double bagged in zip lock bags before shipment. Check with the analytical laboratory being used to find out how it prefers to receive the concrete samples.

All sampling equipment used for a given location must be decontaminated before use at the next sampling location. This includes the hammer, chisel, bowl, towel, and core drill bit.

## Attachments

None.

## Key Checks and Items

Check that the core drilling rig is in working order before beginning operations. Check the condition of the core drilling bit after each run. If the bit shows excessive wear, have it replaced. If possible, try to choose sample locations where a water source can be accessed.

# Direct Push Soil Sample Collection

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## Purpose

The purpose of this FOP is to provide a general guideline for the collection of soil and groundwater grab samples using direct push (e.g., GeoProbe®) sampling methods.

## Scope

The method described for direct push soil sampling is applicable for soil sampling at and below the ground surface and groundwater grab samples at discrete intervals within the saturated zone. Specific equipment and responsibilities of direct push subcontractors are described in contracting documentation.

## Equipment and Materials

- Truck-mounted hydraulic percussion hammer
- Sampling rods
- Sampling tubes and liners (for soil samples)
- Photoionization detector or flame ionization detector
- CGI
- Double hook-bladed knife or other tool for opening liners
- Clean latex or surgical gloves as specified in the Health and Safety Plan
- Precleaned sample containers, stainless steel sampling equipment, coolers and other sampling supplies as referred to in the Field Sampling Plan
- Decontamination supplies including 10 percent methanol rinse, nonphosphate soap, and distilled water, paper towels, and plastic sheeting.
- Field notebook, sample data sheets, chain-of-custody forms, and custody seals
- Ice
- Appropriate personal protective equipment
- Tool box
- 55-gallon drum or 5-gallon buckets, with covers, to contain soil and purge water.

Additional groundwater sampling equipment includes:

- Discrete interval groundwater sampler (e.g., GeoProbe Groundwater Profiler or GeoProbe SP-15 Sampler)
- Teflon® or Teflon-lined polyethylene tubing and a peristaltic pump
- An appropriate power source for the pump being used.

## Procedures and Guidelines

### Soil Sampling

1. Ensure sampling tubes and other nondedicated downhole equipment and sampling equipment are decontaminated in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
2. Wear appropriate personal protective equipment, as required by the Health and Safety Plan. Change gloves between sampling locations.
3. Confirm all underground utility clearances have been obtained and maps of private utilities have been consulted.
4. Drive sampling tube to the desired sampling depth using the truck-mounted hydraulic percussion hammer. If soil above the desired depth is not to be sampled, first drive the lead rod, without a sampling tube, to the top of the desired depth.
5. Remove the rods and sampling tube from the borehole and, using the double hook-bladed knife or other tool, carefully split the liner to allow access for removing the sample from the tube.
6. Conduct photoionization detector readings at soil intervals as agreed by the field technician and field team leader, and record the data as specified in the Field Sampling Plan. At least one photoionization detector reading should be taken on each explicitly logged soil interval. Log the soil sample according to visual methods outlined in ASTM Method D 2487-98.
7. Fill all sample containers using decontaminated sampling equipment, beginning with the containers for VOC analysis. (See FOP 07, *Volatile Organic Compound Soil Sample Collection*.) Soil samples for inorganic and nonvolatile organic analyses will be separated and transferred into stainless steel bowls, homogenized by mixing with a stainless steel spoon, and transferred to the appropriate sample container. Remove large pebbles and cobbles from sample before placing in jars.
8. Label, handle, and store the sample according to procedures outlined in the Field Sampling Plan. Record sampling data such as depth, time, and date as specified in the Field Sampling Plan. Discard unused sample according to the guidelines for investigation-derived waste.
9. Decontaminate all nondedicated downhole equipment (rods, sampling tubes, etc.) in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.

10. Additional sampling may be required at the location. The location should be secured and clearly marked to prevent slip/trip/fall injuries. Abandonment should only be performed after discussions with the field team leader and project team.

## Groundwater Grab Sampling

1. Ensure rods, groundwater samplers, and other nondedicated downhole equipment and sampling equipment are decontaminated in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
2. Wear appropriate personal protective equipment, as required by the Health and Safety Plan. Change gloves between sampling locations.
3. Confirm all underground utility clearances have been obtained and maps of private utilities have been consulted.
4. Advance sampler to the base of the target interval using the truck-mounted hydraulic percussion hammer. Upon reaching base of the target depth interval, expose screened interval of the sampler for groundwater collection.
5. Collect groundwater samples in accordance with the following protocols:
  - Wear a new pair of gloves for each new sample.
  - Prior to sampling, purge each probe using a Teflon bailer or dedicated section of Teflon or Teflon-lined polyethylene tubing and a peristaltic pump. Purge rates should be kept below 1 L/min to ensure minimal turbidity. At least three casing volumes of water will be purged from the sampler prior to sample collection to ensure collection of a representative sample.
  - After purging the required volume, collect groundwater samples. Fill containers using techniques to minimize sample agitation.
6. Remove the rods and sampling equipment from the borehole.
7. Label, handle, and store the sample according to procedures outlined in the Field Sampling Plan. Record sampling data such as depth, time, and date as specified in the Field Sampling Plan. Discard unused sample according to the guidelines for investigation-derived waste.
8. Decontaminate all nondedicated downhole equipment (rods, sampling tubes, etc.) in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
9. Additional sampling may be required at the location. The location should be secured and clearly marked to prevent slip/trip/fall injuries. Abandonment should only be performed after discussions with the field team leader and project team.

## Attachments

None.



## Reference

ASTM Method D 2487-98.

## Key Checks and Items

1. Verify that the hydraulic percussion hammer is clean and in proper working order.
2. Monitor that the direct push operator thoroughly completes the decontamination process between sampling locations.
3. Determine if a QC sample will be required at a sampling location (refer to the Field Sampling Plan). If additional sample volume is required, another direct push advancement to the same depth interval may be needed.
4. Collect rinse water investigation-derived waste and containerize with well development and purge water.
5. Verify that the borehole made during sampling activities has been properly backfilled and the surface restored.

# Membrane Interface Probe Sample Collection

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## Purpose

The purpose of this FOP is to provide a general guideline for measuring concentrations of volatile organic concentrations (VOCs) in soil using direct-push membrane interface probe (MIP) sampling methods.

## Scope

The method described for direct-push MIP soil screening is applicable for soils at and below the ground surface. Specific equipment and responsibilities of direct push and MIP subcontractors are described in contracting documentation.

## Equipment and Materials

- Truck-mounted hydraulic percussion hammer
- Sampling rods
- Membrane interface probe w/detectors
- Laptop computer or other display device
- Printer for preparing report of results
- Camera and field logbook
- Sampling tubes and liners
- Photoionization detector or flame ionization detector
- CGI
- Clean latex or surgical gloves as specified in the Health and Safety Plan
- Precleaned sample containers, stainless-steel sampling equipment, and other sampling supplies as referred to in the FSP

## Procedures and Guidelines

Procedures for MIP investigation will be determined based on anticipated contaminant concentration. If VOC concentrations are expected to be less than 10 ppm, follow procedure "A." If VOC concentrations are expected to exceed 10 ppm (indicative of NAPL), follow procedure "B."

Before the MIP investigation begins, the operator will calibrate the system using a minimum of a stock TCE calibration solution. The calibration procedures and results will be recorded in the field notebook.

The specific detectors used as part of the MIP system will depend on the equipment of the selected subcontractor. The MIP system specified will include at minimum a photoionization

detector and an electron capture device. Additional detectors, such as a flame-ionization detector, may be used depending on the selected subcontractor's equipment.

### **MIP Procedure A (VOCs < 10 ppm)**

1. Ensure sampling rods and other nondedicated downhole equipment and sampling equipment are decontaminated in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
2. Wear appropriate personal protective equipment, as required by the Health and Safety Plan. Change gloves between sampling locations.
3. If the target location is inside the building, confirm the concrete floor has been cored to allow MIP advancement.
4. Beginning at ground surface, push the MIP to a depth of 1 foot below ground, and allow the temperature of the probe to recover to the operational temperature of 121°C. Verify that all monitoring and recording equipment is operational.
5. Advance the MIP in 2-foot, discrete intervals, allowing the temperature of the probe to recover to 121°C and readings to stabilize before advancing the next 2-foot interval. As the temperature of the probe reaches 121°C diffusion of the target compounds through the membrane is accelerated. Diffusion will occur because of the concentration gradient between the impacted media and the clean carrier gas behind the membrane. The constant flow of carrier gas behind the membrane sweeps the diffused gas to the detectors.
6. Continue 2-foot advancement intervals to the top of the till surface at approximately 30 feet below ground. If refusal is encountered at a depth above the anticipated till surface, the probe will be removed, the boring will be abandoned in accordance with FOP-06, *Monitoring Well and Soil Boring Abandonment*, and a new probe location will be attempted at an offset of 6 feet. The offset probe location will use the same location ID; however, consecutive letters will be added to identify the locations as offsets (e.g., MIP-01A, MIP-01B). Offset locations will be clearly labeled for surveying and so the location can be revisited at a future time, if necessary. Offset locations will be noted in the field logbook with the depth of refusal at the previous location. Approximate direction (north, west, etc.) and distance of offset will also be recorded in the field logbook.
7. Confirmation soil samples will be collected from the unsaturated zone and groundwater grab samples will be collected from selected depth intervals at 10 percent of all MIP locations. The soil and groundwater grab samples will be collected in accordance with FOP-03, *Direct Push Sample Collection*.
8. At the completion of each MIP location, decontaminate all nondedicated downhole equipment (rods, sampling tubes, etc.) in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
9. At the completion of investigation at a sample location, the borehole will remain open until evaluation is performed by the field team leader to determine if a temporary well will be installed at the location. The open borehole will be covered and caution tape will be placed around the location to identify the area as an open borehole.

## MIP Procedure B (VOCs > 10 ppm)

1. Ensure sampling rods and other nondedicated downhole equipment and sampling equipment are decontaminated in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
2. Wear appropriate personal protective equipment, as required by the Health and Safety Plan. Change gloves between sampling locations.
3. If the target location is inside the building, confirm the concrete floor has been cored to allow MIP advancement.
4. Beginning at the ground surface, push the MIP to a depth of 1 foot below ground, and allow the temperature of the probe to recover to the operational temperature of 121°C. Verify that all monitoring and recording equipment is operational.
5. Advance the MIP at a constant rate of 0.5 cm/sec to 2.0 cm/sec to the top of the till layer at approximately 30 feet below ground. DO NOT stop probe advancement to allow the temperature of the probe to recover.
6. If refusal is encountered at a depth above the anticipated till surface, the probe will be removed, the boring will be abandoned in accordance with FOP-06, *Monitoring Well and Soil Boring Abandonment*, and a new probe location will be attempted at an offset of 6 feet. The offset probe location will use the same location ID; however, consecutive letters will be added to identify the locations as offsets (e.g., MIP-01A, MIP-01B). Offset locations will be clearly labeled for surveying so that the location can be revisited in the future, if necessary. Offset locations will be noted in the field logbook with the depth of refusal at the previous location. Approximate direction (north, west, etc.) and distance of offset will also be recorded in the field logbook.
7. Confirmation soil samples will be collected from the unsaturated zone and groundwater grab samples will be from discrete select depth intervals at 10 percent of all MIP locations. Soil and groundwater grab samples will be collected in accordance with FOP-03, *Direct Push Sample Collection*.
8. At the completion of each MIP location, decontaminate all nondedicated downhole equipment (rods, sampling tubes, etc.) in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
9. At the completion of investigation at a sample location, the borehole will remain open until evaluation is performed by the field team leader to determine if a temporary well will be installed at the location. The open borehole will be covered and caution tape will be placed around the location to identify the area as an open borehole.

## Attachments

None.

## Key Checks and Items

1. Verify the hydraulic percussion hammer is clean and in proper working order.
2. Monitor that the direct-push operator thoroughly completes the decontamination process between sampling locations.
3. Determine if a QC sample will be required at a sampling location (refer to the FSP). If additional sample volume is required, another direct-push advancement to the same depth interval may be needed.
4. Collect rinse water investigation-derived waste and containerize with well development and purge water.
5. Verify that the borehole made during sampling activities has been properly backfilled and the surface restored.

# Hollow-Stem Auger Drilling and Soil Sample Collection

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## Purpose

The purpose of this FOP is to provide a general guideline for the collection of soil samples using hollow-stem auger drilling methods.

## Scope

The method described for hollow-stem auger soil sampling is applicable for soil and sediment sampling below the ground surface. Specific equipment and the responsibilities of hollow-stem auger drilling subcontractors are described in the contracting documentation.

## Equipment and Materials

As specified in ASTM Method D-1586-99.

## Procedures and Guidelines

1. Ensure that augers, split-barrel samplers (split spoons), and other non-dedicated downhole equipment and sampling equipment are decontaminated in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
2. Wear appropriate PPE, as required by the HSP. Change gloves between sampling locations.
3. While drilling, subsurface soil samples will be collected continuously from the ground surface to the bottom of the boring using 2-foot-long, split-barrel samplers advanced in accordance with ASTM Method D-1586-99. Between sampling intervals, the samplers will be decontaminated in accordance with the procedures outlined in FOP-17, *Decontamination of Drilling Rigs and Equipment*. Between drilling locations, the drill rig and downhole tools will also be decontaminated in accordance with the same FOP.
4. The drilling operators will open the sampler and present it to the field staff for logging and sampling. Conduct PID readings at soil intervals as agreed by the field technician and the field team leader, and record the data as specified in the FSP. In general, at least one PID reading should be taken on each explicitly logged soil interval. Log the soil sample according to visual methods outlined in ASTM Method D-2487-98.
5. Fill all sample containers using decontaminated sampling equipment, beginning with the containers for VOC analysis (see FOP-07, *Volatile Organic Compound Soil Sample Collection*). Soil samples for inorganic and nonvolatile organic analyses will be separated

and transferred into stainless steel bowls, homogenized by mixing with a stainless steel spoon, and transferred to the appropriate sample container. Remove large pebbles and cobbles from sample before placing in jars.

6. Label, handle, and store the sample according to procedures outlined in the Field Sampling Plan. Record sampling data such as depth, time, and date as specified in the FSP. Discard unused sample according to the guidelines for investigation-derived waste outlined in the Soil Management Plan.
7. After a subsurface soil sample is collected, the hollow-stem augers will be advanced to the next sampling interval. During auger advancement, a bottom plug or drill bit will be inserted into the auger to prevent soils from collecting within the auger annulus. Before collection of the next soil sample, the bottom plug or drill bit will be temporarily removed from the auger. This method of sampling, auger advancement, and sampling will continue to the depth of the boring.
8. The drilling subcontractor will be responsible for obtaining accurate and representative soil samples, informing the hydrogeologist of changes in drilling conditions, and keeping a separate general log of the soil samples collected and blow counts (i.e., the number of hammer blows required to advance the sampler 6 inches into the ground).
9. Decontaminate all non-dedicated downhole equipment (rods, sampling tubes, etc.) in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.
10. Backfill borehole at each sampling location with grout or bentonite and repair the surface with like material (bentonite, asphalt patch, concrete, etc.), as required.

## Attachments

None.

## References

- ASTM Method D-1586-99
- ASTM Method D-2487-98

## Key Checks and Items

1. Verify that the drilling rig is clean and in proper working order.
2. Monitor that the drilling operator thoroughly completes the decontamination process between sampling locations.
3. Determine if a QC sample will be required at a sampling location (refer to the FSP).
4. Collect rinse water investigation-derived waste according to the procedures outlined in the Site Management Plan.

# **Monitoring Well and Soil Boring Abandonment**

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## **Purpose**

The purpose of this FOP is to delineate protocols for abandoning boreholes after soil and groundwater sampling is completed. All well and soil borehole abandonment will be conducted in accordance with IEPA Monitor Well Plugging and Abandonment Procedures.

## **Scope**

The method described is applicable for soil borings and temporary and permanent monitoring wells. Specific equipment and responsibilities of drilling subcontractors are described in contracting documentation.

## **Equipment and Materials**

- Truck-mounted drill rig
- Neat cement or high solids bentonite grout (Aquaguard or Benseal)
- Tremie pipe (1-inch ID PVC)
- PID and/or FID
- CGI
- Bentonite chips
- Clean latex or surgical gloves as specified in the Health and Safety Plan

## **Procedures and Guidelines**

### **Monitoring Wells (Temporary and Permanent)**

Procedures for abandonment of monitoring wells vary by well construction.

**Well Construction Type I-A: Unconsolidated wells if backfilled with cement grout above bentonite seal and/or sandpack or for unknown well construction**

1. Cut casing to desired depth.
2. Mix neat cement slurry (5 gallons of potable water per 94-pound bag of neat cement).
3. Insert tremie pipe (1-inch ID PVC) into well and extend to the bottom of the well.
4. Slowly pump slurry under low pressure through tremie pipe.
5. Slowly withdraw tremie pipe, making sure bottom of tremie pipe remains below pure slurry.



6. Continue slow pumping until all formation water and the water slurry mix is displaced from top of casing.
7. Collect all displaced formation water for treatment and disposal. Collect all slurry mixture and add to soil cuttings for disposal as investigative waste.
8. Check abandonment location 24 hours after abandonment is completed to verify no settlement of grout has occurred. If settlement has occurred, add additional grout to the borehole and recheck in 24 hours.

**Monitoring Well Construction Type I-B: Unconsolidated wells backfilled with soft sediments (cuttings) above bentonite seal and/or sand pack**

- Knock out and remove this surface concrete plug, if present.
- Reauger entire length of well.
- Remove well casing from reaugured borehole.
- Mix neat cement slurry (5 gallons of potable water per 94-pound bag of neat cement).
- Insert tremie pipe (1-inch ID PVC) into well and extend to the bottom of the well.
- Slowly pump slurry under low pressure through tremie pipe.
- Slowly withdraw tremie pipe, making sure bottom of tremie pipe remains below pure slurry.
- Pull a flight of augers (5 inches if in unstable materials and hole collapse is likely, or 10 inches if in competent material and collapse is unlikely).
- Top off cement slurry after each flight is removed.
- A well abandonment form will be completed for the location.

**Soil Borings**

- At the completion of a soil boring, remove all drill auger and rods or direct push equipment from the borehole.
- Backfill the borehole to ground surface with bentonite chips slowly to avoid bridging.
- Add one gallon of potable water to the borehole after the bentonite chips are added to hydrate any bentonite above the water table.
- Twenty-four hours after abandonment, inspect the location to determine if settling has occurred. If settling has occurred, add more bentonite chips to bring the level to ground surface. The location will be rechecked after 24 hours and the process repeated if necessary.
- Complete a borehole abandonment form for each location.

## **Attachments**

IEPA Monitor Well Plugging and Abandonment Procedures (IAC 920.120).

## **Key Checks and Items**

- Verify grout level after 24 hours.
- Mix ratio of neat cement grout should be 5 gallons of potable water to 94-pound bag of neat cement or high-solids bentonite. Grout should be mixed according to manufacturer's specifications.

# ILLINOIS EPA MONITOR WELL PLUGGING AND ABANDONMENT PROCEDURES

	Well Construction		Plugging Procedure
I. Unconsolidated Sediment Wells	I-A	...if backfilled with cement grout above bentonite seal and/or sandpack:	<ol style="list-style-type: none"> <li>1. Cut casing off at desired depth.</li> <li>2. Mix neat cement slurry (5 gal. water per 94 lb. bag cement).</li> <li>3. Insert tremi pipe (1" i.d. pvc) into well and extend to bottom.</li> <li>4. Slowly pump slurry under low pressure through tremi pipe.</li> <li>5. Slowly withdraw tremi pipe - making sure bottom of pipe remains below pure slurry.</li> <li>6. Continue slow pumping until all formation water and the watery slurry mix is displaced from top of casing.</li> </ol>
	I-B	...if backfilled with soft sediments (cuttings) above bentonite seal and/or sandpack:	<ol style="list-style-type: none"> <li>1. Knock out and remove thin surface concrete plug, if present.</li> <li>2. Re-auger entire length of well.</li> <li>3. Remove well casing from re-augured borehole.</li> <li>4. Mix neat cement slurry (5 gal. water per 94 lb. bag cement).</li> <li>5. Insert tremi pipe (1" i.d. pvc) into augers and extend to bottom.</li> <li>6. Slowly pump slurry under low pressure through tremi pipe.</li> <li>7. Continue slow pumping until all formation water and the water slurry mix is displaced from top of casing.</li> <li>8. Slowly withdraw tremi pipe - making sure bottom of pipe remains below pure slurry.</li> <li>9. Pull a flight of augers (5" if in unstable materials and hole collapse is likely or 10" if in competent material and collapse is unlikely).</li> <li>10. Top off cement slurry after each flight is removed.</li> </ol>
	I-C	...if monitor well construction is unknown:	<ol style="list-style-type: none"> <li>1. Follow procedures in I-A.</li> </ol>
II. Bedrock Wells	II-A	...All bedrock monitor wells:	<ol style="list-style-type: none"> <li>1. Cut casing off at desired depth.</li> <li>2. Mix neat cement slurry (5 gal. water per 94 lb. bag cement).</li> <li>3. Insert tremi-pipe (1" i.d. pvc) into well and extend to bottom.</li> <li>4. Slowly pump slurry under low pressure through tremi pipe.</li> <li>5. Slowly withdraw pipe making sure bottom of pipe remains below pure slurry.</li> <li>6. Continue slow pumping until all formation water and the watery slurry mix is displaced from top of casing.</li> </ol>

Well Plugging Procedures (revised 02/06/02)

# Volatile Organic Compound Soil Sampling

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## Purpose and Scope

The purpose of this FOP is to provide a general guideline for the collection of volatile organic compound (VOC) soil samples using OLM04.3 or SW-846 Methods 1311 and 8260B sampling methods.

## Equipment and Materials

- Disposable syringe-type coring device, or En Core<sup>®</sup>-type samplers and En Core-type T-handle
- Decontamination supplies, including 10 percent methanol rinse, nonphosphate soap, and distilled water, paper towels, mixing bowls and spoons, and aluminum foil
- Sample bottles and cooler for submittal to the laboratory
- Field notebook, sample data sheets, chain-of-custody forms, and custody seals
- Ice
- Clean latex or surgical style chemical-resistant gloves and additional appropriate personal protective equipment
- PID, explosimeter, and oxygen meter (LEL/O<sub>2</sub>) and calibration gases, as appropriate
- Tool box
- 55-gallon drum or 5-gallon buckets, with covers, to contain investigation-derived wastes

During the preparation for the field event, the list should be reviewed and modified, as appropriate, to accommodate sample collection of additional analytes or other site-related activities.

## Procedures and Guidelines

This technique provides for the handling of intact soil cores, the preservation options of those soil cores in hermetically sealed containers, and the minimization of analyte loss because of direct volatilization and biodegradation.

## Use of En Core-type Hermetically Sealed Containers

Three En Core-type samplers are collected. Two aliquots are needed for low-level analysis and reanalysis, if necessary. One aliquot is needed for extraction in methanol by the laboratory in the case where high-concentration target analytes are indicated during low-level analysis.

Exposure to the air must be minimized by obtaining the soil subsample directly from the sample source (i.e., steel sleeve, wide-mouth jar, etc.) using the En Core sampler.

VOC samples will be placed in a cooler containing enough ice to maintain an internal air temperature of 4°C. Samples will be shipped the same day as collection. The field team will ship the samples by overnight express delivery. The 4°C temperature in the cooler must be maintained throughout its route to the laboratory. Samples must be analyzed within 48 hours of collection if not frozen/preserved by the laboratory. The laboratory may freeze/preserve the samples (if done so within 48 hours of sample collection time) to extend the holding time to 7 days, if frozen, and 14 days, if preserved in bisulfate solution or methanol. If no other analyses are being performed, a 2-oz jar of soil must also be collected to analyze for percent moisture.

## Attachments

None.

## Key Checks and Items

- Check that samples are immediately stored and remain at 4°C minimum.
- Check that the drilling operator thoroughly completes the decontamination process between sampling locations.

# Soil Oxidant Demand Sample Collection

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## Purpose and Scope

The purpose of this FOP is to describe the collection of soil samples using soil oxidant demand sampling methods.

## Equipment and Materials

- Brass sleeves or liners for use with a split-spoon or Shelby tube sampler and associated caps needed to secure sample before shipping
- Teflon® tape or foil
- Permanent marker
- Decontamination supplies including 10 percent methanol rinse, nonphosphate soap, and distilled water, paper towels, mixing bowls and spoons, and aluminum foil
- Sample bottles (8-ounce, wide-mouth, glass jar) and cooler for submittal to the laboratory
- Field notebook, sample data sheets, chain-of-custody forms, and custody seals
- Ice
- Clean latex or surgical-style, chemical-resistant gloves and additional appropriate PPE
- PID, explosimeter, and oxygen meter (LEL/O<sub>2</sub>) and calibration gases, as appropriate
- Tool box
- 55-gallon drum or 5-gallon buckets, with covers, to contain investigation-derived wastes

During the preparation for the field event, the list should be reviewed and modified, as appropriate, to accommodate sample collection of additional analytes or other site-related activities.

## Procedures and Guidelines

This technique provides for the handling of split-spoon or Shelby tube soil sampling cores (potentially with brass liners and intact cores), the preservation options of these soil cores in sealed containers, and the minimization of analyte loss due to direct volatilization and biodegradation.

## Sample Collection and Characterization

The samples will be used to evaluate the oxidant demand of unsaturated soils near the contaminated water-bearing zone. The sampling interval for the borings may be modified, or samples may be obtained from a specific depth, based on field observations. A decontaminated split-spoon sampler or a continuous coring device (i.e., Shelby tube) shall be used to obtain samples during the drilling of each boring. The sampler may be lined with brass sleeves (if intact cores are required). The details of this sample collection effort (i.e., number of samples, sampling methods, handling, shipping, etc.) will be provided in the FSP.

If brass sleeves are implemented, upon recovery of the sample, one or more brass sleeves shall be removed from the split-spoon sampler or the Shelby tube. The open ends shall be covered with Teflon tape or foil and sealed with plastic caps fastened with tape for shipment to the analytical laboratory. The sample depth and the top of the sample shall be clearly marked. Soil samples will be collected in sampling tubes with minimal headspace and immediately sealed to prevent loss of VOCs.

If brass liners are not used, the sample will be collected from the split-spoon or Shelby tube sampler and placed in an 8-ounce, wide-mouth, glass jar with minimal headspace, and immediately sealed to prevent loss of VOCs.

Soil oxidant demand samples will be placed in a cooler containing enough ice to maintain an internal air temperature of 4°C. Samples will be expressed shipped (i.e., overnight delivery) on ice to the laboratory for analysis. The 4°C temperature in the cooler must be maintained throughout its route to the laboratory. The samples will be immediately analyzed for the soil oxidant demand.

## Attachments

None.

## Key Checks and Items

- Check that samples are immediately stored and remain at 4°C minimum.
- Check that the drilling operator thoroughly completes the decontamination process between sampling locations.

# **Monitoring Well Installation and Development**

---

## **Purpose**

The purpose of this FOP is to review well installation procedures. These procedures are to be considered general guidelines only, and are in no way intended to supplement or replace the contractual specifications in the driller's subcontract.

## **Scope**

Installation of permanent groundwater monitoring wells in unconsolidated deposits.

## **Equipment and Materials**

- Health and safety equipment
- YSI® multiprobe or equivalent instruments for measuring pH, temperature, specific conductance, and turbidity
- Storage for purge water
- Surge block
- Photoionization detector

## **Procedures and Guidelines**

1. Monitoring wells will be installed in accordance with IEPA regulations.
2. The threaded connections will be watertight.
3. A record of the finished well construction will be compiled.
4. Soils and liquids generated during well installation and development will be drummed for proper disposal according to the Transportation and Disposal Plan.

### **Unconsolidated Well Installation (Hollow-Stem Auger Drilling Methods)**

1. The monitoring wells will be installed using hollow-stem auger drilling methods. For the purposes of installing a 2-inch-diameter monitoring well, augers with at least a 4¼-inch inside diameter will be used. The monitoring well shall be sufficiently plumb and straight such that there is no interference with the utilization of sampling equipment.
2. While drilling, subsurface soil samples will be collected continuously from the ground surface to the bottom of the boring using 2-foot-long (minimum), split-barrel samplers advanced in accordance with ASTM Method D-1586-99.



3. After the augers have been advanced to the required depth and soil sampling is complete as specified by the onsite hydrogeologist, the monitoring well materials will be installed through the augers as specified in ASTM Method D-5784-95. Monitoring well materials will be dependent on the well location, depth, and subsurface conditions. If NAPL is suspected at the location, 2-inch-diameter, stainless-steel well screen and riser pipe with 0.010-inch slot, continuous wire-wrapped screen will be used. Wells installed where NAPL is not suspected will consist of Schedule 40, 2-inch-diameter PVC materials with 0.010-inch machine slotted 5-foot-length well screen flush-threaded to an appropriate length of flush-joined, riser pipe. A cap will be flush-threaded to the bottom of the well screen.
4. A sand filter pack, consisting of a washed and graded silica sand with at least 90 percent of the retained grain size greater than 0.010 inch, will be placed between the outside of the well screen and the borehole wall. A downhole tape measure will be used to assess the proper emplacement of the sand filter pack. The sand filter pack will extend from 6 inches below the bottom of the well screen to 2 feet above the top of the well screen.
5. A bentonite seal, consisting of bentonite chips or pellets, will be placed on top of the sand filter pack, and will be a minimum thickness of 2 feet and no greater than 3 feet. If the seal extends above the groundwater table, potable water will be used to hydrate the bentonite for a minimum of 2 hours before proceeding with the next step.
6. Following installation of the bentonite seal, the remaining annular space between the outside of the riser casing and the borehole wall will be filled with a cement/bentonite grout mixture. The grout mixture will be prepared in the following proportions: 94 pounds of cement (one bag) thoroughly mixed with about 6 gallons of water. Approximately 2 to 3 pounds of powdered bentonite per bag of cement will be added to reduce the amount of shrinkage as the grout cures. A premixed, high-solids grout (e.g., Aquaguard or Benseal) may also be used for annular seal grout.
7. For water table observation wells constructed in areas where the depth to the water table is less than 5 feet bgs, the required filter pack height above the top of the well screen may be reduced to 6 inches to allow for the placement of the required amount of annular space sealant.
8. A locking compression plug will be inserted into the top of the riser casing. A flush-mounted protective casing will be installed over the top of the riser casing and cemented in place.
9. Monitoring well specifications will be recorded on a monitoring well construction form. An example of this form is attached.
10. Excess drill cuttings will be contained in labeled, 55-gallon drums staged as designated in the Transportation and Disposal Management Plan.

## Well Development

Subsequent to installation, the monitoring wells will be developed to remove fine-grained materials that may have settled in and around the well screen during installation, and to maximize the ability of the well to transmit representative portions of groundwater. Well

development activities will be conducted a minimum of 24 hours after completion of well installation activities to allow the cement around the well to cure.

Well development will be completed using an appropriate method such as a low-yield, submersible pump. Development will be accomplished by surging the well screen with a surge block, followed by purging the suspended sediments. Water quality parameters such as pH, temperature, and specific conductance will be periodically monitored during development to assess stabilization of these parameters. Well development will continue until the well yields relatively sediment-free water and/or the monitored water parameters have stabilized. These parameters are considered stabilized when pH measurements agree within 0.5 unit, temperature measurements agree within 1°C, and specific conductance measurements agree within 10 percent. A well development record will be maintained by the onsite hydrogeologist to document the well development methods used, the estimated volume of water purged, and the results of the water quality parameters monitored.

Fluids generated during well development activities will be contained in labeled, 55-gallon drums staged as designated in the IDW Management Plan. Development water may also be transferred into bulk storage poly tanks. Equipment used during well development will be decontaminated between monitoring well locations in accordance with FOP-17, *Decontamination of Drilling Rigs and Equipment*.

## Attachments

- Illinois Administrative Code 920.170
- Soil Boring Log
- Well Completion Diagram
- Well Development Log

## References

ASTM Method D-5784-95.

## Key Checks and Items

None.

## **Joint Committee on Administrative Rules**

# **ADMINISTRATIVE CODE**

**TITLE 77: PUBLIC HEALTH  
PART 920 ILLINOIS WATER WELL CONSTRUCTION CODE  
CHAPTER I: DEPARTMENT OF PUBLIC HEALTH  
SECTION 920.170 MONITORING WELLS**

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### **Section 920.170 Monitoring Wells**

This Section shall apply to all monitoring wells, except those wells installed to monitor chemicals leaking from underground storage tanks which are installed within the excavation made for the installation of the underground storage tank.

- a) **Casing.** All monitoring wells shall have casing which meets the requirements of Section 920.90(a), except where the design specifications require the use of another material. Threaded joints shall be required where plastic casing is used. Casing must be clean, free of rust, grease, oil or contaminants and be composed of materials, including but not limited to steel and plastic, that will not affect the quality of the water sample. All casing shall be watertight. The casing shall be centered in the borehole, be free of any obstructions and allow sampling devices to be lowered into the well.
- b) **Well Screen.** All monitoring well screens shall be constructed of non-corrosive and non-reactive material. All well screens shall be permanently joined to the well casing and shall be centered in the borehole.
- c) **Filter Packs.** All monitoring wells installed in unconsolidated material shall be constructed with filter packs. When used, the filter pack shall be the only material in contact with the well screen.
  - 1) The filter pack shall consist of sand or gravel. The sand or gravel used for filter packs shall have an average specific gravity of not less than 2.50. The filter pack material shall be sized to match the screen slot size and the surrounding formation to prevent the formation materials from entering the screen. The sand or gravel shall be free of clay, dust and organic matter. Crushed limestone, dolomite or any material containing clay or any other material that will adversely affect the performance of the monitoring well shall not be used as filter pack.
  - 2) **Installation.** The filter pack shall extend a maximum of 6 inches below the bottom of the screen to 2 feet above the top of the screen. For water table observation wells constructed in areas where the depth to the water table is less than 5 feet, the required filter pack

height above the top of the well screen may be reduced to 6 inches to allow for the required amount of annular space sealant to be placed.

- d) **Grouting Requirements.** All materials and procedures used in the installation of annular seals for groundwater monitoring wells shall meet the requirements of this Section. The annular sealing material above the filter pack shall prevent the migration of fluids from the surface and between aquifers. Sealing material shall be chemically compatible with anticipated contaminants.
  - 1) **Annular Space Seal.** All monitoring wells shall be installed with an annular space seal. The annular seal shall extend from the top of the filter pack to the surface.
  - 2) **Above Ground Surface Completion.** Where the monitoring well does not terminate flush with the ground surface in accordance with Section 920.170(d)(3), the casing shall extend at least 8 inches above the ground surface. The top of the casing shall be provided with a locking cap. If the monitoring well is located in a floodplain, the cap shall be watertight. Protective devices, such as rings of brightly colored posts around the well, shall be installed in areas where the casing is likely to be struck by farm vehicles or by individuals who are unaware of the existence of the well.
  - 3) **Ground Surface Completion.** Monitoring well casing may terminate at the ground surface provided a flush-mounted well completion pipe is installed over the casing. The flush-mounted completion pipe shall consist of a metal casing at least four inches larger in diameter than the well casing. Monitoring wells terminating at the surface may be allowed only in areas traveled by vehicles. The flush-mounted well completion pipe shall have a water tight seal and the annular opening around the well completion pipe shall be grouted. The well casing shall be sealed with a watertight locking cap.
- e) **Drilling Methods and Fluids.** The drilling method shall introduce the least possible amount of foreign material into the borehole, produce the least possible disturbance to the formation and permit the proper construction and development of the required diameter well. Water from a source free of bacterial and chemical contamination shall be used in the drilling fluid mixture.
- f) **Disposal and Decontamination.**
  - 1) All drill cuttings and fluids and surge and wash waters from borehole and monitoring well construction and development shall be disposed of in a manner which will not result in contamination of the immediate area or result in a hazard to individuals who may come in contact with these materials.
  - 2) All monitoring well construction equipment shall be decontaminated

by washing and triple rinsing or high pressure heat cleaning to prevent cross-contamination of monitoring wells or in accordance with design specifications, whichever is more stringent.

**g) Special Circumstances and Exceptions.**

- 1) The Department may require more restrictive or alternative well material, assembly or installation if the contaminant concentrations or geologic setting require alternative construction.**
- 2) Variances to the requirements of this subsection may be approved by the Department prior to installation or abandonment. A variance request shall state the reasons why compliance with the rule is impractical or impossible. The Department shall approve a variance when it can be shown that the particular contaminant or drilling method requires alternative materials or procedures to safeguard against contamination of the groundwater.**

**h) Abandonment or Decommissioning of Monitoring Wells. All abandoned monitoring wells shall be sealed in accordance with Section 920.120.**

**i) Reporting. Within 30 days after a monitoring well has been constructed or abandoned, the owner, designer or consulting firm shall submit a report of construction or abandonment to the Department on such forms as are prescribed and furnished by the Department.**

**(Source: Amended at 18 Ill. Reg. 17684, effective November 30, 1994)**

PROJECT NUMBER	BORING NUMBER	SHEET	OF
SOIL BORING LOG			

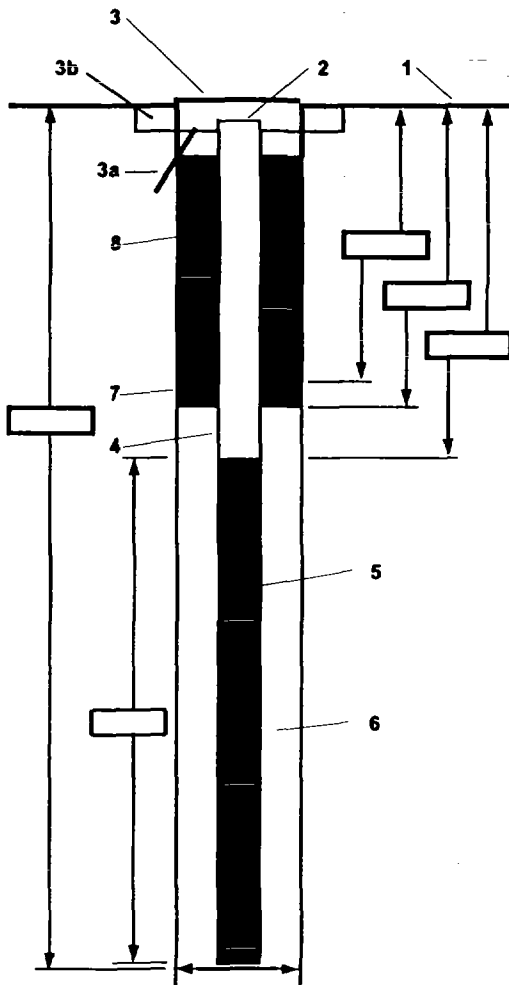
PROJECT :		LOCATION :	
ELEVATION :		DRILLING CONTRACTOR :	
DRILLING METHOD AND EQUIPMENT USED :			
WATER LEVELS :	START :	END :	LOGGER :

[illegible]

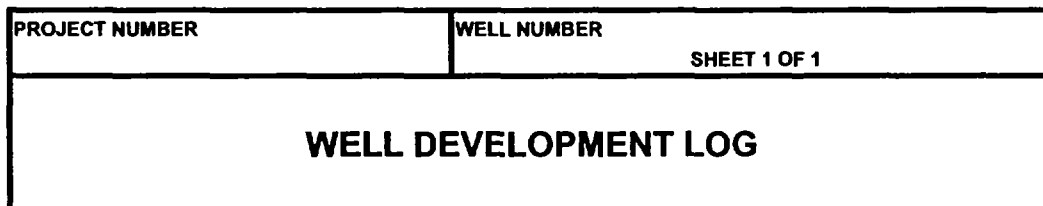


PROJECT NUMBER	WELL NUMBER
SHEET 1 OF 1	
<b>WELL COMPLETION DIAGRAM</b>	

PROJECT :	LOCATION :		
DRILLING CONTRACTOR :			
DRILLING METHOD AND EQUIPMENT USED :			
WATER LEVELS :	START :	END :	LOGGER :



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	
a) drain tube?	
b) concrete pad dimensions	
4- Dia./type of well casing	
5- Type/slot size of screen	
6- Type screen filter	
a) Quantity used	
7- Type of seal	
a) Quantity used	
8- Grout	
a) Grout mix used	
b) Method of placement	
c) Vol. of well casing grout	
Development method	
Development time	
Estimated purge volume	
Comments	



**LOCATION:**

**DEVELOPMENT METHOD AND EQUIPMENT USED:**

**START:**

**LOGGER:**

**RANGE AND AVERAGE DISCHARGE RATE:**

**TOTAL QUANTITY OF WATER DISCHARGED:**

DISPOSITION OF DISCHARGE WATER:

[illegible]



# Groundwater Level Measurement

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## Purpose

The purpose of this FOP is to delineate protocols for measuring water level and well depths in groundwater monitoring wells.

## Scope

The method described for measurement of groundwater levels is applicable for all permanent and temporary monitoring wells.

## Equipment and Materials

- Water-level indicator with cable measured at 0.01-foot increments
- Plastic sheeting
- Folding ruler or pocket steel tape
- Field logbook
- PID

## Procedures and Guidelines

1. Locate the well and verify its position on the site map. Record whether positive identification was obtained, including the well number and any identifying marks or codes contained on the well casing or protective casing.
2. Remove the well cap and check for organic vapors using a PID.
3. Locate and record the specified benchmark or survey point for the well, which may be a mark at the top of the casing or surveyor's pin embedded in the protective structure. Determine from the records and note in the field logbook the elevation of this point. Measure and record the vertical distance from the bench mark to the top of the well casing, to the nearest 0.01 foot. Measure and record the metal casing stick-up (the distance between the top of the casing and nominal ground level).
4. Record any observations and remarks regarding the completion characteristics and well condition, such as evidence of cracked casing or surface seals, security of the well (locked cap), and evidence of tampering.
5. Keep all equipment and supplies protected from contamination. Keep the water level indicator probe in its protective case when not in use.

6. Remove the water level indicator probe from the case, turn on the sounder, and test check the battery and sensitivity scale by pushing the red button. Adjust the sensitivity scale until you can hear the buzzer.
7. Slowly lower the probe and cable into the well, allowing the cable reel to unwind. Continue lowering until the meter buzzes. Very slowly, raise and lower the probe until the point is reached where the meter just begins to buzz. Marking the spot by grasping the cable with the thumb and forefinger at the top of the casing, withdraw the cable and record the depth.
8. To measure the well depth, lower the probe until slack is noted in the cable. Very slowly raise and lower the cable until the exact bottom of the well is "felt." Measure and record the depth.

## **Attachments**

None.

## **Key Checks and Items**

Check the batteries of the water level indicator each time the instrument is used.

# Low-Flow Groundwater Sampling Procedures

---

## Purpose

The purpose of this FOP is to describe procedures for collecting groundwater samples using low-flow methods. Methods were developed in accordance with procedures presented in USEPA publications.

## Scope

This procedure is applicable for monitoring wells that are 1 inch in diameter or greater, and is considered to be appropriate for collections of VOCs, SVOCs, PCBs, and metals. This procedure is not appropriate for the collection of LNAPLs or DNAPLs. Operations manuals should be consulted for specific calibration and operating procedures.

## Equipment and Materials

The following list presents the equipment needed for low-flow groundwater sampling of organic site-related constituents, as specified in the FSP.

- Electronic water level indicator with an accuracy of 0.01 foot.
- Electronic oil/water interface probe with an accuracy of 0.01 foot.
- Sampling pump with adjustable flow rate. *Must be either gear driven, helical driven, air-activated piston, or low-flow centrifugal.* An adjustable-rate peristaltic pump can be used when the depth to water is 20 feet or less if the other pump types are not readily available.
- Teflon® or Teflon®-lined polyethylene tubing.
- An appropriate power source for the sampling pump being used.
- A graduated container to determine volume and a watch to monitor flow rate and time.
- YSI® Model 6920 (or comparable) multi-parameter meter with flow-through cell. At a minimum, the meter must be capable of measuring pH, oxidation-reduction potential, dissolved oxygen, turbidity, specific conductance, and temperature.
- Calibration solutions for the multi-parameter meter.
- Decontamination supplies including 10 percent methanol rinse, non-phosphate soap, and distilled water, paper towels, and plastic sheeting.
- Sample bottles and coolers for submittal to the laboratory.
- Field notebook, sample data sheets, chain-of-custody forms, and custody seals.

- Ice.
- Appropriate PPE.
- PID, explosimeter, and oxygen meter (LEL/O<sub>2</sub>) and calibration gases, as appropriate.
- Tool box.
- 55-gallon drum or 5-gallon buckets, with covers, to contain purge water.

During the preparation for the field event, the list should be reviewed and modified, as appropriate, to accommodate sample collection of additional analytes or other site-related activities.

## Procedures and Guidelines

The following activities shall be completed before the start of purging and sampling:

1. Calibrate the multi-parameter meter, PID, and LEL/O<sub>2</sub> meter. Record all calibration information in the field notebook.
2. Begin sampling at the monitoring well with the lowest concentrations of site-related constituents based on the results of the previous sampling event. Exceptions may be necessary to accommodate site-specific conditions. If no previous groundwater data are available, results of a MIP investigation may be used to determine areas of higher VOCs.
3. Inspect the protective well cover, concrete pad, inner well casing, and locking cap of the monitoring well and record observations in the field notebook. Polyethylene sheeting should be placed on the ground to minimize the potential for sampling equipment to contact the soil. Monitoring, purging, and sampling equipment should be placed on the sheeting.
4. Monitor the headspace of the well with the PID and LEL/O<sub>2</sub> meters immediately after removing the inner casing cap. Readings should be noted in the field notebook. Refer to the site-specific HSP for required actions based on PID and LEL/O<sub>2</sub> readings.
5. Measure the depth to water in the well. Also check the well for nonaqueous-phase liquids using the oil/water interface probe. Total well depth measurement using the oil/water interface probe should not be collected until all samples have been collected to minimize turbidity generated in the well. Measurements will be recorded on sample data sheets and in the field notebook.

## Purging and Sampling Activities

Procedures for purging and sampling are as follows:

1. Slowly lower the pump and tubing into the monitoring well until the pump intake is set near the midpoint of the screened interval. Record the depth of the pump intake (feet below top of inner well casing) in the field notebook.
2. Remeasure the depth to water and record the information on the sample data sheets. Leave the water level indicator in the well.

3. Place the multi-parameter meter into the flow-through cell. Connect the discharge end of the tubing from the pump to the flow-through cell of the multi-parameter probe. Place the flow-through cell discharge tubing into the 55-gallon drum or a 5-gallon bucket for collection of purge water.
4. Set the flow rate on the pump to the lowest setting, turn the pump on, and slowly increase the flow rate until water begins to flow. Using a graduated cylinder to monitor the flow rate, adjust the pump until a rate of 50 to 500 mL per minute is reached. Maintain a steady flow rate while keeping drawdown to less than 0.33 foot. If drawdown is greater than 0.33 foot, reduce the pumping rate. If a drawdown of less than 0.33 foot cannot be achieved, continue purging and record the groundwater levels and flow rate every 5 minutes.
5. Provided the drawdown does not exceed 0.33 foot (see above), record the discharge rates and drawdown on the sampling data sheets every 5 minutes, and continue purging at a flow rate to minimize drawdown. A minimum of one tubing volume must be purged before recording water quality parameters.
6. After a minimum of one tubing volume has been purged, record the values of the water quality parameters. After the initial measurement, record the water quality parameter readings concurrently with the discharge rate and drawdown measurements.
7. Continue purging until three successive readings of the water quality field parameters stabilize, following the criteria in Table 1, below. When the water quality parameters stabilize, collect the samples.

**TABLE 1**  
Stabilization Criteria with References for Water-Quality-Indicator Parameters

Parameter		Stabilization Criteria
pH	± 0.1	
Specific Electrical Conductance	± 3%	
Oxidation-Reduction Potential	± 10 millivolts	
Turbidity	± 10% (when turbidity > 10 nephelometric turbidity units)	
Dissolved Oxygen	± 0.3 milligrams per liter	

Source: USEPA 2002.

8. If a stabilized drawdown in the well cannot be maintained at less than 0.33 foot and the water level is approaching the top of the well screen, reduce the flow rate or turn the pump off for 15 minutes and allow for recovery. The pump should not be turned off if it does not have a check valve installed inline with the tubing to prevent water flowing out of the tubing into the well. If the pump must be turned off and no check valve is present, the discharge end of the tubing should be clamped to minimize the potential for water to flow back into the well. After 15 minutes, resume pumping, at a lower rate, if possible. If water levels again approach the top of the well screen, turn the pump off and allow another 15 minutes for recovery. If two tubing volumes have been removed (including the volume in the flow-through cell and tubing), collect a sample when the pump is

- turned on. Record this information in the field notebook so that adjustments can be made for the next sampling event.
9. For collection of samples, pumping rates should be maintained to minimize disturbance of the water column. The discharge tubing should be disconnected from the input of the flow-through cell and samples collected directly from the pump discharge tubing. Sample bottles for VOCs and/or dissolved gasses should always be filled first.
  10. Upon sample collection, remove the pump from the well, decontaminate the pump, and dispose of the tubing, if it is not dedicated.

## Attachments

- Low-Flow Well Sampling: Field Data Sheet.
- USEPA. May 2002. *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers*. Groundwater Forum Issue Paper, Technology Innovation Office; Office of Solid Waste and Emergency Response. EPA 542-S-02-001.

## Key Checks and Items

None.

## Low - Flow Well Sampling: Field Data Sheet

Well Number:						Site:					
Field Crew:						Date:					
						Project #:					
Well Depth (ft)			Purge			Diameter	Gal. Per foot	Diameter	Gal. Per foot		
DTW (ft.)			Methodology:			2"	0.163	5"	1.02		
Water Column (ft):											
Well Diameter (in):						3"	0.367	6"	1.469		
Gal. Per ft.:											
Well Volume (gal):						4"	0.653	8"	2.611		
Depth of Screen (ft):											
Field Parameters											
Time	DTW (toc)	Flow Rate (ml/min)	Temp (C)	pH (Std. Units)	SpC (uS/cm)	Cond. (us/cm)	ORP (mV)	D.O. (mg/L)	Turbidity (NTU)	Color/Odor	
1 VOL.											
2 VOL.											
3 VOL.											
4 VOL.											
5 VOL.											
6 VOL.											
7 VOL.											
8 VOL.											
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15 VOL.											
16 VOL.											
17 VOL.											
18 VOL.											
19 VOL.											
Remarks:											
Sampling											
Depth to Water before Sampling											
Sample Methodology:											
Sample Date/Time:											
Signed Sampler:											
Filtered Metals Collected: Y / N Filter Size:											
Sample Observations:											



# Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers

## GROUND WATER FORUM ISSUE PAPER

Douglas Yeskis\* and Bernard Zavala\*\*

### BACKGROUND

The Ground Water, Federal Facilities and Engineering Forums were established by professionals from the United States Environmental Protection Agency (USEPA) in the ten Regional Offices. The Forums are committed to the identification and resolution of scientific, technical, and engineering issues impacting the remediation of Superfund and RCRA sites. The Forums are supported by and advise OSWER's Technical Support Project, which has established Technical Support Centers in laboratories operated by the Office of Research and Development (ORD), Office of Radiation Programs, and the Environmental Response Team. The Centers work closely with the Forums providing state-of-the-science technical assistance to USEPA project managers.

This document provides sampling guidelines primarily for ground-water monitoring wells that have a screen or open interval with a length of ten feet or less and which can accept a sampling device. Procedures that minimize disturbance to the aquifer will yield the most representative ground-water samples. This document provides a summary of current and/or recommended ground-water sampling procedures. This document was developed by the Superfund/RCRA Ground Water Forum and incorporates comments from ORD, Regional Superfund hydrogeologists and others. These guidelines are applicable to the majority of sites, but are not intended to replace or supersede regional and/or project-specific sampling plans. These

guidelines are intended to assist in developing sampling plans using the project-specific goals and objectives. However, unusual and/or site-specific circumstances may require approaches other than those specified in this document. In these instances, the appropriate Regional hydrologists/geologists should be contacted to establish alternative protocols.

### ACKNOWLEDGMENTS

A document of this scope involved significant participation from a number of people, such that any omission in these acknowledgments is purely unintentional. We thank all of the participants involved in the development of this document! The authors acknowledge the active participation and valuable input from the committee from the Ground Water Forum of Dick Willey, Region 1; Ruth Izraeli and Kevin Willis, Region 2; Kathy Davies, Region 3; Robert Puls, ORD-NRMRL; and Steve Gardner, ORD-NERL. In addition, valuable input from former members of the committee are gratefully acknowledged. And finally, the peer reviews of the document completed by Franceska Wilde of the Water Division of the U.S. Geological Survey, Reston, VA; Richard Duwelius and Randy Bayless of the Indiana District of the U.S. Geological Survey, Indianapolis, IN; Steve White of the Omaha District of the U.S. Army Corps of Engineers, Omaha, NE and Karl Pohlmann of the Desert Research Institute, Las Vegas, NV are gratefully acknowledged.



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## INTRODUCTION

The goal of ground-water sampling is to collect samples that are "representative" of in-situ ground-water conditions and to minimize changes in ground-water chemistry during sample collection and handling. Experience has shown that ground-water sample collection and handling procedures can be a source of variability in water-quality concentrations due to differences in sampling personnel, sampling procedures, and equipment (U.S. Environmental Protection Agency, 1995).

Several different ground-water sampling procedures can be used, which vary primarily through the criteria used to determine when a sample is representative of ground-water conditions. No single method or procedure is universally applicable to all types of ground-water-sampling programs; therefore, consideration should be given to a variety of factors when

determining which method is best suited to site-specific conditions. These site-specific conditions include sampling objectives, equipment availability, site location, and physical constraints. This paper will discuss each of these conditions and how they may contribute to the decision in choosing the appropriate sampling methodology and equipment to be used during ground-water sampling.

This paper focuses on ground-water sampling procedures for monitoring wells only where separate, free-phase, Non-Aqueous Phase Liquids (NAPLs) are not present in the monitoring well. Residential and/or municipal-production wells where special sampling procedures and considerations need to be implemented are not discussed in this document. The recommendations made in this paper are based on findings presented in the current literature, and will be subject to revision as the understanding of ground-water-sampling procedures increases.

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## SAMPLING OBJECTIVES

The objective of a good sampling program should be the collection of a "representative" sample of the current ground-water conditions over a known or specified volume of aquifer. Ideally to meet this objective, sampling equipment, sampling method, monitoring well construction, monitoring well operation and maintenance, and sample handling procedures should not alter the chemistry of the sample. A sample that is obtained from a poorly constructed well, or using improper sampling equipment, or using poor sampling techniques, or which has been preserved improperly, can bias the sampling results. Unrepresentative samples can lead to misinterpretations of ground-water-quality data. Generally, the costs of obtaining representative ground-water samples are insignificant when compared to potential remedial responses that may be implemented based on erroneous data or when considering the overall monitoring program costs over the life of the program (Nielson, 1991).

The data quality objectives (DQOs) of the sampling program should be thoroughly developed, presented and understood by all parties involved. To develop the DQOs, the purpose of the sampling effort and data use(s) should be clearly defined. The sampling guidelines presented here can be used for a variety of monitoring programs, these include site assessment, contaminant detection, site characterization, remediation, corrective action and compliance monitoring.

For example DQOs for a site characterization sampling effort might vary from those of a remediation monitoring sampling effort. This difference could be in how much of the screen interval should be sampled. A site characterization objective may be to collect a sample that represents a composite of the entire (or as close as is possible) screened interval of the monitoring well. On the other hand, the monitoring objective of a remediation monitoring program may be to obtain a sample that represents a specific portion of the screened interval.

Additionally, the site characterization may require analyses for a broad suite of contaminants, whereas, the remediation monitoring program may require fewer contaminants to be sampled. These differences

may dictate the type of sampling equipment used, the type of information collected, and the sampling protocol.

In order to develop applicable DQOs, a site conceptual model should be developed. The site conceptual model should be a dynamic model which is constantly revised as new information is collected and processed. The conceptual model, as it applies to the DQOs, should focus on contaminant fate and transport processes, such as contaminant pathways, how the geologic materials control the contaminant pathways (depositional environments, geologic structure, lithology, etc.), types of contaminants present (i.e., hydrophobic versus hydrophilic), and the processes that influence concentrations of the contaminants present such as dilution, biodegradation, and dispersion. The detail of the conceptual model will depend greatly on the availability of information, such as the number of borings and monitoring wells and the amount of existing analytical data. Clearly, a site that is being investigated for the first time will have a much simpler conceptual model compared to a site that has had a Remedial Investigation, Feasibility Study, and Remedial Design, (or, within the RCRA Program, a RCRA Facility Assessment, a RCRA Facility Investigation, and a Corrective Measures Study), and is currently in remediation/corrective action monitoring. Specific parameters that a conceptual model should describe that may impact the design of a ground-water-sampling program include:

- a) The thickness, lateral extent, vertical and horizontal flow direction, and hydraulic conductivity contrasts of the geologic materials controlling contaminant transport from the site (thick units versus thin beds versus fractures, etc.)
- b) The types of contaminants to be sampled (volatile organic compounds, semi-volatile organic compounds, metals, etc.) and factors that could bias sampling results (turbidity for metals, co-solvation effects on PCBs, etc.)
- c) Lateral and vertical distribution of contamination (contaminants distributed throughout an entire unit being monitored versus localized distribution controlled by small scale features, etc.)

Vertical aquifer characterization is strongly recommended prior to the completion of a ground-water monitoring well installation program. A detailed vertical aquifer characterization program should include field characterization of hydraulic conductivities, determination of vertical and horizontal flow directions, assessment of lithologic and geologic variations, and determination of vertical and horizontal contaminant distributions. The successful aquifer characterization program provides detailed information to guide the technical and cost-effective placement, vertically and areally, of monitoring wells.

### **INFORMATION NEEDED PRIOR TO SAMPLING**

To ensure appropriate methodology and expedient collection of water-quality samples, information is needed before a sample is collected. Some information should be obtained prior to the start of field activities such as well condition, construction, water-level information, contaminant types and concentrations, and direction(s) of ground-water flow. Field measurements, such as depth to water and total well depth will be needed prior to purging. Before commencement of all field activities, the field health and safety plan should be consulted under the direction of the site health and safety officer.

### **BACKGROUND DATA**

Well construction and maintenance information are needed to better plan the sampling program, optimize personnel, and obtain more representative samples. Prior to field activities, personnel should have specific information including well casing diameter, borehole diameter, casing material, lock number and keys, physical access to wells, and length of and depth to well screen. The diameter of each well casing is used to select the correct equipment and technique for purging and sampling the well. A site map with possible physical barriers and description of access is necessary to allow for the selection of proper equipment based on several factors, such as portability, ease of repair, power sources, containment of purge water, and well accessibility. The length and depth of each well screen and depth to water is important when placing a sampling device's intake at the proper depth for purging and sampling and for choosing a sampling device. Well development information is needed to ensure that purging and sampling rates will not exceed well development extraction rates. Previous sampling information should be provided and

evaluated to determine the nature and concentrations of expected contaminants. This will be useful in determining the appropriate sampling method and quality assurance/quality control (QA/QC) samples (for example, field duplicates, equipment blanks, trip blanks). Attachment 1 is an example of a sampling checklist for field personnel. This information should be kept in the field for easy access during sampling activities.

When evaluating previous sampling information, consideration should be given to the amount of time that has expired between the last sampling effort and the planned sampling effort. If this time exceeds one year, the need for redevelopment of the monitoring wells should be evaluated. The necessity of redevelopment can be evaluated by measuring constructed depth compared to the measured depth. If the depth measurement indicates siltation of the monitoring well screen, or evidence exists that the well screen is clogged, the well should be redeveloped prior to sampling. The assessment of the condition of the monitoring wells should be completed several weeks prior to sampling activities in order to allow the proper recovery of the developed wells. This is especially important in wells where prior sampling has indicated high turbidity. The time for a well to re-stabilize after development is dependent on site-specific geology and should be specified in the site sampling plan. The development method, if necessary, should be consistent with the sampling objectives, best technical criteria and USEPA guidelines (Aller et al., 1991; Izraeli et al., 1992; Lapham et al., 1997).

### **REFERENCE POINT**

Each well should be clearly marked with a well identifier on the outside and inside of the well casing. Additionally, each well should have a permanent, easily identified reference point from which all depth measurements are taken. The reference point (the top of the inner casing, outer casing, or security/protective casing) should remain constant through all measurements, should be clearly marked on the casing and its description recorded. Whenever possible, the inner casing is recommended as a reference point, because of the general instability of outer casings due to frost heaving, vehicular damage, and other phenomena which could cause movement of casings. The elevation of this reference point should be known and clearly marked at the well site (Nielson, 1991).

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This reference point should also have a known latitude and longitude that are consistent with the Regional and National Minimum Data Elements requirements. The elevation of the reference point should be surveyed relative to Mean Sea Level (MSL) using the NAVD 88 datum.

#### TOTAL WELL DEPTH

The depth of the well is required to calculate the volume of standing water in the well and to document the amount of siltation that may have occurred. Moreover, measuring the depth to the bottom of a well provides checks for casing integrity and for siltation of the well screen. Corrosion can cause leaking or collapse of the well casing, which could lead to erroneous or misleading water-level measurements. Corrosion, silting, and biofouling can clog well screens and result in a sluggish response or no response to water-level changes, as well as changes in ground-water chemistry. Well redevelopment or replacement may be needed to ensure accurate collection of a representative water-quality sample.

Total well depths should be measured and properly recorded to the nearest one-tenth of a foot using a steel tape with a weight attached. The steel tape should be decontaminated before use in another well according to the site specific protocols. A concern is that when the steel tape and weight hit the bottom of the well, sediment present on the bottom of a well may be stirred up, thus increasing turbidity which will affect the sampling results. The frequency of total well depth measurements varies, with no consensus for all hydrogeologic conditions. The United States Geological Survey (USGS) recommends a minimum of once a year (Lapham et al., 1997). USEPA also recommended one measurement per year (Barcelona et al., 1985) but later recommended a total well depth be taken every time a water-quality is collected or a water-level reading taken (Aller et al., 1991). Therefore, when possible, the total depth measurements should be taken following the completion of sampling (Puls and Barcelona, 1996). When total-well-depth measurements are needed prior to sampling, as much time as possible should be allowed prior to sampling, such as a minimum of 24 hours. The weight of electric tapes are generally too light to determine accurate total well depth. If the total well depth is greater than 200 feet, stretching of the tape must be taken into consideration.

#### DEPTH TO WATER

All water levels should be measured from the reference point by the use of a weighted steel tape and chalk or an electric tape (a detailed discussion of the pros and cons of the different water level devices is provided in Thornhill, 1989). The steel tape is a more accurate method to take water levels, and is recommended where shallow flow gradients (less than 0.05 foot/foot or 0.015 meter/meters) or deep wells are encountered. However, in those cases where large flow gradients or large fluctuations in water levels are expected, a calibrated electric tape is acceptable. The water level is calculated using the well's reference point minus the measured depth to water. At depths approximately greater than 200 feet, the water-level-measuring device should be chosen carefully, as some devices may have measurable stretching.

The depth-to-water measurement must be made in all wells to be sampled prior to activities in any single well which may change the water level, such as bailing, pumping, and hydraulic testing. All readings are to be recorded to the nearest one-hundredth of a foot.

The time and date of the measurement, point of reference, measurement method, depth-to-water level measurement, and any calculations should be properly recorded. In addition, any known, outside influences (such as tidal cycles, nearby pumping effects, major barometric changes) that may affect water levels should be noted.

#### GROUND-WATER SAMPLING METHODS

The ground-water sampling methods to be employed should be dependent on site-specific conditions and requirements, such as data-quality objectives and well accessibility. Ground-water sampling methods vary based on the type of device used, the position of the sampler intake, the purge criteria used, and the composition of the ground water to be sampled (e.g., turbid, containing high volatile organics, etc.). All sampling methods and equipment should be clearly documented, including purge criteria, field readings, etc. Examples of appropriate documentation are provided in Attachment 2 of this document and Appendix E of the U.S. Environmental Protection Agency, 1995 document.

The water in the screen and filter pack is generally in a constant state of natural flux as ground water passes in and out of the well. However, water above the screened section remains relatively isolated and become stagnant. Stagnant water is subject to physiochemical changes and may contain foreign material, which can be introduced from the surface or during well construction, resulting in non-representative sample data. To safeguard against collecting a sample biased by stagnant water, specific well-purging guidelines and techniques should be followed.

A non-representative sample also can result from excessive pumping of the monitoring well. Stratification of the contaminant concentrations in the aquifer may occur, or heavier-than-water compounds may sink to the lower portions of the aquifer. Excessive pumping can dilute or increase the contaminant concentrations from what is representative of the sampling point.

#### PURGING AND SAMPLING DEVICES

The device used to purge and sample a well depends on the inner casing diameter, depth to water, volume of water in the well, accessibility of the well, and types of contaminants to be sampled. The types of equipment available for ground-water sampling include hand-operated or motor-driven suction pumps, peristaltic pumps, positive displacement pumps, submersible pumps, various in-situ devices and bailers made of various materials, such as PVC, stainless steel and Teflon®. Some of these devices may cause volatilization and produce high pressure differentials, which could result in variability in the results of pH, dissolved oxygen concentrations, oxidation-reduction potential, specific electrical conductance, and concentrations of metals, volatile organics and dissolved gases. Therefore, the device chosen for well purging and sampling should be evaluated for the possible effects it may have on the chemical and physical analyses. In addition, the types of contaminants, detection levels, and levels of concern as described by the site DQOs should be consulted prior to the selection of a sampling device. The same device used for purging the monitoring well should be used for sampling to minimize agitation of the water column (which can increase turbidity, increase volatilization, and increase oxygen in the water).

In general, the device used for purging and sampling should not change geochemical and physical parameters and/or should not increase turbidity. For this reason, low-flow submersible or positive-displacement pumps that can control flow rates are recommended for purging wells. Dedicated sampling systems are greatly preferred since they avoid the need for decontamination of equipment and minimize turbulence in the well. If a sampling pump is used, the pump should be lowered into the well as slowly as possible and allowed to sit as long as possible, before pumping commences. This will minimize turbidity and volatilization within the well.

Sampling devices (bladders, pumps, bailers, and tubing) should be constructed of stainless steel, Teflon®, glass, and other inert materials to reduce the chance of these materials altering the ground water in areas where concentrations of the site contaminants are expected to be near detection limits. The sample tubing thickness should be maximized and the tubing length should be minimized so that the loss of contaminants through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of many materials makes the appropriate selection of sample tubing materials critical for these trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998). Existing Superfund and RCRA guidance suggest appropriate compatible materials (U.S. Environmental Protection Agency, 1992). Special material considerations are important when sampling for non-routine analyses, such as age-dating and biological constituents.

Preferably, wells should be purged and sampled using a positive-displacement pump or a low-flow submersible pump with variable controlled flow rates and constructed of chemically inert materials. If a pump cannot be used because the recovery rate is so slow (less than 0.03 to 0.05 gallons per minute or 100 to 200 milliliters per minute) and the volume of the water to be removed is minimal (less than 5 feet (1.6 meters) of water), then a bailer with a double check valve and bottom-emptying device with a control-flow check valve may be used to obtain the samples. Otherwise, a bailer should not be used when sampling for volatile organics because of the potential bias introduced during sampling (Pohlmann, et al., 1990; Yeskis, et al., 1988; Tai, et al., 1991). A peristaltic

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pump also may be used under these conditions, unless the bias by a negative pressure may impact the contaminant concentrations of concern (generally at depths greater than 15 to 20 feet (4.5 to 6 meters) of lift). Bailers should also be avoided when sampling for metals due to increased turbidity that occurs during the deployment of the bailer, which may bias inorganic and strongly hydrophobic parameters. Dedicated sampling pumps are recommended for metals sampling because the pumps avoid the generation of turbidity from frequent sampler deployment (Puls et al., 1992). A number of alternate sampling devices are becoming available, including passive diffusion samplers (Vroblesky and Hyde, 1997; Vroblesky, 2001a and b) and other in-situ sampling devices. These devices may be particularly useful to sampling low-permeability geologic materials, assuming the device is made of materials compatible with the analytical parameters, meet DQOs, and have been properly evaluated. However, the site investigator should ensure the diffusion membrane materials are selected for the contaminants of concern (COCs) present at the site. Comparison tests with an approved sampling method and diffusion samplers should be completed to confirm that the method is suitable for the site.

#### POSITION OF SAMPLE INTAKE

Essentially there are two positions for placement of the sample pump intake, within the screen and above the screen. Each of the positions offers advantages and disadvantages with respect to the portion of the well screen sampled, data reproducibility and potential purge volumes.

When the sampling pump intake is set above the well screen, the pump generally is set just below the water level in the well. The sampling pump then is pumped until a purge criterion is reached (commonly either stabilization of purge parameters or a set number of well volumes). If the distance between the water level and the top of the screen is long, there is concern that the water will be altered geochemically as it flows along the riser pipe, as water flows between the well screen and the sampling pump intake. This is especially a concern if the riser pipe is made of similar material as the COC (such as a stainless steel riser with nickel as a COC, or PVC with organics as a COC). Keely and Boateng (1987) suggested that to minimize this potential influence, the sample pump be lowered gradually while purging, so that at the time of

the sampling the pump intake is just above the screen. This would minimize contact time between the ground water and the well construction materials while sampling, as well as ensure the evacuation of the stagnant water above the screen.

With the final location of the sampling pump intake just above the well screen, the sample results may be more reproducible than those collected by positioning the pump intake within the well screen. Results may be more reproducible because the sampler can ensure that the ground water is moving into the well with the same portions of the aquifer being sampled each time assuming the same pump rate. If the pump is placed into different portions of the screen each time, different portions of the aquifer may be sampled. Of course, this can be avoided by the use of dedicated, permanently installed equipment. Additionally, the placement of the pump at the same vertical position within the screen can be ensured by the use of calibrated sampling pump hose, sounding with a weighted tape, or using a pre-measured hose.

The placement of the pump above the screen does not guarantee the water-quality sample represents the entire well screen length. Any bias in the pump placement will be consistently towards the top of the well screen and/or to the zone of highest hydraulic conductivity. Another possible disadvantage, or advantage, depending on the DQOs, of the placement of the pump above the well screen is that the sample may represent a composite of water quality over the well screen. This may result in dilution of a portion of the screen that is in a contaminated portion of an aquifer with another portion that is in an uncontaminated portion of the aquifer. However, shorter well screens would minimize this concern.

When the pump intake is positioned within the well screen, its location is recommended to be opposite the most contaminated zone in the well screen interval. This method is known as the low-flow, low-stress, micropurge, millipurge, or minimal drawdown method. The well is then purged with a minimal drawdown (usually 0.33 feet (0.1 meters) based on Puls and Barcelona, 1996) until selected water-quality-indicator parameters have stabilized. Use of this method may result in the vertical portion of the sampled aquifer being smaller than the well screen length. This method is applicable primarily for short well-screen

lengths (less than 5 feet (1.6 meters)) to better characterize the vertical distribution of contaminants (Puls and Barcelona, 1996). This method should not be used with well-screen lengths greater than 10 feet (3 meters). By using this method, the volume of purge water can be reduced, sometimes significantly, over other purging methods.

However, two potential disadvantages of this method exist. The first potential disadvantage may involve the lower reproducibility of the sampling results. The position of the sampling pump intake may vary between sampling rounds (unless adequate precautions are taken to lower the pump into the exact position in previous sampling rounds, or a dedicated system is used), which can result in potentially different zones within the aquifer being sampled. This potential problem can be overcome by using dedicated sampling pumps and the problem may be minimized by the use of short well screens. The second potential disadvantage, or advantage, depending on the DQOs, may be that the sample which is collected may be taken from a small portion of the aquifer volume.

#### PURGE CRITERIA

##### "Low-Stress Approach"

The first method for purging a well, known as the low-stress approach, requires the use of a variable-speed, low-flow sampling pump. This method offers the advantage that the amount of water to be containerized, treated, or stored will be minimized. The low-stress method is based on the assumption that pumping at a low rate within the screened zone will not draw stagnant water down, as long as drawdown is minimized during pumping. Drawdown should not exceed 0.33 feet (0.1 meters) (Puls and Barcelona, 1996). The pump is turned on at a low flow rate approximating the estimated recovery rate (based on the drawdown within the monitoring well during sampling). This method requires the location of the pump intake to be within the saturated-screened interval during purging and sampling. The water-quality-indicator parameters (purge parameters), pH, specific electrical conductance, dissolved oxygen concentration, oxidation-reduction potential, temperature and turbidity, are monitored at specific intervals. The specific intervals will depend on the volume within the tubing (include pump and flow-through cell volumes), pump rate and drawdown; commonly every three to

five minutes. These parameters should be recorded after a minimum of one tubing volume (include pump and flow-through-cell volumes) has been purged from the well. These water-quality-indicator parameters should be collected by a method or device which prevents air from contacting the sample prior to the reading, such as a flow-through cell (Barcelona et al., 1985; Garske and Schock, 1986; Wilde et al., 1998). Once three successive readings of the water-quality-indicator parameters provided in Table 1 have stabilized, the sampling may begin. The water-quality-indicator parameters that are recommended include pH and temperature, but these are generally insensitive to indicate completion of purging since they tend to stabilize rapidly (Puls and Barcelona, 1996). Oxidation-reduction potential may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions, and for some fate and transport issues. When possible, especially when sampling for contaminants that may be biased by the presence of turbidity, the turbidity reading is desired to stabilize at a value below 10 Nephelometric Turbidity Units (NTUs). For final dissolved oxygen measurements, if the readings are less than 1 milligram per liter, they should be collected with the spectrophotometric method (Wilde et al., 1998, Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). All of these water-quality-indicator parameters should be evaluated against the specifications of the accuracy and resolution of the instruments used.

During purging, water-level measurements must be taken regularly at 30-second to five-minute intervals (depending on the hydraulic conductivity of the aquifer, diameter of the well, and pumping rate) to document the amount of drawdown during purging. The water-level measurements will allow the sampler to control pumping rates to minimize drawdown in the well.

##### "Well-Volume Approach"

The second method for purging wells is based on proper purging of the stagnant water above the screened interval and the stabilization of water-quality-indicator parameters prior to sampling. Several considerations in this method need to be evaluated before purging. For monitoring wells where the water level is above the screens, the pump should be set

near the top of the water column, and slowly lowered during the purging process. For water columns within the well screen, the pump should be set at a sufficient depth below the water level where drawdown during pumping does not allow air to enter the pump. The pump should not be allowed to touch or draw sediments from the bottom of the well, especially when sampling for parameters that may be impacted by turbidity. The well-purging rate should not be great enough to produce excessive turbulence in the well, commonly no greater than one gallon per minute (3.8 liters per minute) in a 2-inch well. The pump rate during sampling should produce a smooth, constant (laminar) flow rate, and should not produce turbulence during the filling of bottles. As a result, the expected flow rate for most wells will be less than one gallon per minute (3.8 liter per minute), with expected flow rates of about one-quarter gallon per minute (500 milliliter per minute).

The stabilization criteria for a "well-volume approach" may be based on the stabilization of water-quality-indicator parameters or on a pre-determined well volume. Various research indicates that purging criteria based on water-quality-indicator parameter stabilization may not always correlate to stabilization of other parameters, such as volatile organic compounds (Gibs and Imbrigiotta, 1990; Puls et al., 1990). A more technically rigorous sampling approach that would yield more consistent results over time would be a time-sequential sampling program at regular well-volume intervals while measuring water-quality-indicator parameters. However, the cost would be prohibitive for most sites. For comparison of water-quality results, by sampling under the same conditions (same purge volume and rate, same equipment, same wells, etc.) temporal evaluations of trends may be considered.

The stabilization requirements of the water-quality-indicator parameters are consistent with those described above for the low-stress approach. The parameters should be recorded approximately every well volume; when three successive readings have reached stabilization, the sample(s) are taken (Barcelona et al., 1985). If a ground-water monitoring well has been sufficiently sampled and characterized (at least several rounds of water-quality samples obtained, including the field parameters, during several seasonal variations), and if water-quality-indicator

parameters are no longer needed as a part of site characterization and/or monitoring, then samples could be obtained based on a specific number of well volumes at the previous pumping rates.

#### LOW-PERMEABILITY FORMATIONS

Different procedures must be followed in the case of slow-recovery wells installed in low hydraulic conductivity aquifers. The following procedures are not optimum, but may be used to obtain a ground-water sample under less than ideal conditions. One suggested procedure is to remove the stagnant water in the casing to just above the top of the screened interval, in a well screened below the water table, to prevent the exposure of the gravel pack or formation to atmospheric conditions (McAlary and Barker, 1987). At no point should the pump be lowered into the screened interval. The pumping rate should be as low as possible for purging to minimize the drawdown in the well. However, if a well has an open interval across the water table in a low permeability zone, there may be no way to avoid pumping and/or bailing a well dry (especially in those cases with four feet of water or less in the well and at a depth to water greater than 20 to 25 feet (which is the practical limit of a peristaltic pump)). In these cases, the well may be purged dry. The sample should be taken no sooner than two hours after purging and after a sufficient volume for a water-quality sample, or sufficient recovery (commonly 90%) is present (Herzog et al., 1988). In these cases, a bailer with a double check valve with a flow-control, bottom-emptying device may be used, since many sampling pumps may have tubing capacities greater than the volume present within the well. If the depth of well and water column are shallow enough, consideration of a very low-flow device, such as a peristaltic pump, should be considered, especially if constituents are present that are not sensitive to negative pressures that may be created with the use of the peristaltic pump. If such constituents are present and sampled with a peristaltic pump, a negative bias may be introduced into the sampling results. To minimize the bias, thick-walled, non-porous tubing should be used, except for a small section in the pump heads, which require a greater degree of flexibility. As stated earlier in this paper, the DQOs for the sampling should be consulted to consider the potential impact of the sampling device on the potential bias versus the desired detection levels.



Another method to be considered for low-permeability conditions is the use of alternative sampling methods, such as passive diffusion samplers and other in-situ samplers. As more sites are characterized with these alternative sampling methods and devices, the potential bias, if any, can be evaluated with regard to the sampling DQOs. Regional hydrologists/geologists and Regional quality-assurance specialists should be consulted on the applicability of these methods for the site-specific conditions.

#### **DECISION PROCESS FOR DETERMINING APPLICABLE SAMPLING METHODOLOGY**

Once the project team has determined the sampling objectives and DQOs, reviewed the existing data, and determined the possible sampling devices that can be used, the team must decide the appropriate sampling methodology to be used. Table 2 provides a summary of considerations and rationale to be used in establishing the proper ground-water-sampling program using site-specific conditions and objectives.

#### **POTENTIAL PROBLEMS**

The primary objective is to obtain a sample representative of the ground water moving naturally (including both dissolved and particulate species) through the subsurface. A ground-water sample can be compromised by field personnel in two primary ways: taking an unrepresentative sample and handling the (representative) sample incorrectly. There are numerous ways of introducing foreign contaminants into a sample. These must be avoided by following strict sampling protocols and transportation procedures, and utilizing trained personnel. Common problems with sampling include the use of inappropriate sample containers and field composites, and the filtration of turbid samples.

#### **SAMPLE CONTAINERS**

Field samples must be transferred from the sampling equipment to the container that has been specifically prepared for that given parameter. Samples must not be composited in a common container in the field and then split in the lab. The USEPA Regional policy on sample containers should be consulted to determine the appropriate containers for the specified analysis.

#### **FIELD FILTRATION OF TURBID SAMPLES**

The USEPA recognizes that in some hydrogeologic environments, even with proper well design, installation, and development, in combination with the low-flow purging and sampling techniques, sample turbidity cannot be reduced to ambient levels. The well construction, development, and sampling information should be reviewed by the Regional geologists or hydrologists to see if the source of the turbidity problems can be resolved or if alternative sampling methodologies should be employed. If the water sample is excessively turbid, the collection of both filtered and unfiltered samples, in combination with turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pumping rate, and drawdown data is recommended. The filter size used to determine TSS and TDS should be the same as used in the field filtration. An in-line filter should be used to minimize contact with air to avoid precipitation of metals. The typical filter media size used is 0.45  $\mu\text{m}$  because this is commonly accepted as the demarcation between dissolved and non-dissolved species. Other filter sizes may be appropriate but their use should be determined based on site-specific criteria (examples include grain-size distribution, ground-water-flow velocities, mineralogy) and project DQOs. Filter sizes up to 10.0  $\mu\text{m}$  may be warranted because larger size filters may allow particulates that are mobile in ground water to pass through (Puls and Powell, 1992). The changing of filter media size may limit the comparability of the data obtained with other data sets and may affect their use in some geochemical models. Filter media size used on previous data sets from a site, region or aquifer and the DQOs should be taken into consideration. The filter media used during the ground-water sampling program should be collected in a suitable container and archived because potential analysis of the media may be helpful for the determination of particulate size, mineralogy, etc.

The first 500 to 1000 milliliters of a ground-water sample (depending on sample turbidity) taken through the in-line filter will not be collected for a sample in order to ensure that the filter media has equilibrated to the sample (manufacturer's recommendations also should be consulted). Because bailers have been shown to increase turbidity while purging and sampling, bailers should be avoided when sampling for trace element, metal, PCB, and pesticide constituents. If portable sampling pumps are used, the

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pumps should be gently lowered to the sampling depth desired, carefully avoiding lowering it to the bottom of the well, and allowed to sit in order to allow any particles mobilized by pump placement to settle. Dedicated sampling equipment installed in the well prior to the commencement of the sampling activities is one of the recommended methods to reduce turbidity artifacts (Puls and Powell, 1992; Kearl et al., 1992; Puls et al., 1992; Puls and Barcelona, 1996).

### **SAMPLER DECONTAMINATION**

The specific decontamination protocol for sampling devices is dependent on site-specific conditions, types of equipment used and the types of contaminants encountered. Once removed from the well, non-dedicated sampling equipment should be decontaminated to help ensure that there will be no cross-contamination between wells. Disposable items such as rope and low-grade tubing should be properly disposed between wells. Cleaning thoroughly that portion of the equipment that is going to come into contact with well water is especially important. In addition, a clean plastic sheet should be placed adjacent to or around the well to prevent surface soils from coming in contact with the purging and sampling equipment. The effects of cross-contamination can be minimized by sampling the least contaminated well first and progressing to the more contaminated ones. Equipment blanks should be collected on a regular basis from non-dedicated equipment, the frequency depending on the sampling plan and regional protocols, to document the effectiveness of the decontamination procedures.

The preferred method is to use dedicated sampling equipment whenever possible. Dedicated equipment should still be cleaned on a regular basis to reduce biofouling, and to minimize adsorption effects. Dedicated equipment should have equipment blanks taken after every cleaning.

### **POST-SAMPLING ACTIVITIES**

Specific activities should be completed at monitoring wells at regular intervals to ensure the acquisition of representative ground-water samples. Activities include hydraulic conductivity testing to determine if a monitoring well needs redeveloping and/or replacing. Another activity that needs to be completed is regular surveying of well measuring points impacted by frost

heaving and site activities. The schedules of these activities are to be determined on a site-by-site basis in consultation with regional geologists or hydrologists, but at a minimum, should be every five years.

### **CONCLUSION**

This document provides a brief summary of the state-of-the-science to be used for Superfund and RCRA ground-water studies. As additional research is completed, additional sampling experience with other sampling devices and methods and/or additional contaminants are identified, this paper may be revised to include the new information/concerns. Clearly there is no one sampling method that is applicable for all sampling objectives. As new methods and/or equipment are developed, additional standard operating procedures (SOPs) should be developed and attached to this document. These SOPs for ground-water sampling should include, at a minimum: introduction, scope and application, equipment, purging and sampling procedures, field quality control, decontamination procedures and references. Example SOP's for the low-stress/minimal-drawdown and well-volume sampling procedures have been included as Attachments 3 and 4. These example SOPs are to be considered a pattern or starting point for site-specific ground-water-sampling plans. A more detailed discussion of sampling procedures, devices, techniques, etc. is provided in various publications by the USEPA (Barcelona et al., 1985; U.S. Environmental Protection Agency, 1993) and the U.S. Geological Survey (Wilde et al., 1998).

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## **TABLES:**

**Stablization Criteria with References for  
Water-Quality-Indicator Parameters**

**and**

**Applicability of Different Approaches for Purging  
and Sample Monitoring Wells**

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**TABLE 1: Stabilization Criteria with References for Water-Quality-Indicator Parameters**

<b>Parameter</b>	<b>Stabilization Criteria</b>	<b>Reference</b>
<b>pH</b>	<b>+/- 0.1</b>	<b>Puls and Barcelona, 1996; Wilde et al., 1998</b>
<b>specific electrical conductance (SEC)</b>	<b>+/- 3%</b>	<b>Puls and Barcelona, 1996</b>
<b>oxidation-reduction potential (ORP)</b>	<b>+/- 10 millivolts</b>	<b>Puls and Barcelona, 1996</b>
<b>turbidity</b>	<b>+/- 10% (when turbidity is greater than 10 NTUs)</b>	<b>Puls and Barcelona, 1996; Wilde et al., 1998</b>
<b>dissolved oxygen (DO)</b>	<b>+/- 0.3 milligrams per liter</b>	<b>Wilde et al., 1998</b>



TABLE 2: Applicability of Different Approaches for Purging and Sampling Monitoring Wells

	Low-Stress Approach	Well-Volume Approach	Others (such as passive diffusion samplers, in-situ samplers, and other non-traditional ground-water sampling pumps)
<b>Applicable Geologic Materials<sup>1</sup></b>	Materials with moderate to high hydraulic conductivities. May be applicable to some low hydraulic conductivities, if can meet minimal drawdown criteria.	Materials with low to high hydraulic conductivities	Materials with very low to high hydraulic conductivities
<b>Aquifer/Plume Characterization Data Needs prior to Choosing Sampling Method<sup>2</sup></b>	High definition of vertical hydraulic conductivity distribution and vertical contaminant distribution	Plume and hydraulic conductivity distributions are less critical	May need to consider the degree of hydraulic and contaminant vertical distribution definition dependent on Data Quality Objectives and sampler type.
<b>Constituent Types Method is Applicable</b>	Mainly recommended for constituents which can be biased by turbidity in wells. Applicable for most other contaminants.	Applicable for all sampling parameters. However, if turbidity values are elevated, low-stress approach may be more applicable if constituents of concern are turbidity sensitive.	Constituents of concern will be dependent on the type of sampler.
<b>Data Quality Objectives</b>	1) High resolution of plume definition both vertically and horizontally. 2) Reduce bias from other sampling methods if turbidity is of concern. 3) Target narrow sections of aquifer.	1) Basic site characterization 2) Moderate to high resolution of plume definition (will be dependent on screen length). 3) Target sample composition to represent entire screened/open interval	1) Can be applicable to basic site characterization, depending on sampler and methodology used. 2) Can reduce bias from other sampling methods. 3) May yield high resolution of plume definition.

<sup>1</sup>Hydraulic conductivities of aquifer materials vary from low hydraulic conductivities (clays, silts, very fine sands) to high conductivities (gravels, sands, weathered bedrock zones). This term for the use on this table is subjective, and is more dependent on the drawdown induced in a monitoring well when sampled with a ground-water sampling pump. For instance, in a well being pumped at 4 liters per minute (l/min) with less than 0.1 feet of drawdown, can be considered to have high hydraulic conductivity. A well that can sustain a 0.2 to 0.4 l/min pumping rate, but has more than 0.5 feet of drawdown can be considered to have low hydraulic conductivity. To assign absolute values of hydraulic conductivities to well performance and sustainable pumping rates cannot be completed because of the many factors in monitoring well construction, such as well diameter, screen open area, and length of screen.

<sup>2</sup> See last paragraph under the SAMPLING OBJECTIVES section.

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**ATTACHMENT 1**  
**Example Sampling Checklist**

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Well Identification: \_\_\_\_\_

Map of Site Included: Y or N

Wells Clearly Identified with Roads: Y or N

Well Construction Diagram Attached: Y or N

### Well Construction:

Diameter of Borehole: \_\_\_\_\_ Diameter of Casing: \_\_\_\_\_

Casing Material: \_\_\_\_\_ Screen Material: \_\_\_\_\_

Screen Length: \_\_\_\_\_ Total Depth: \_\_\_\_\_

Approximate Depth to Water: \_\_\_\_\_

Maximum Well Development Pumping Rate: \_\_\_\_\_

Date of Last Well Development: \_\_\_\_\_

**Previous Sampling Information:**

**Was the Well Sampled Previously: Y or N**

(If Sampled, Fill Out Table Below)

[illegible]

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**ATTACHMENT 2**  
**Example Ground-Water Sampling Field Sheets**

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**GROUND-WATER SAMPLING RECORD**

Well ID: \_\_\_\_\_

Facility Name: \_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Station #: \_\_\_\_\_

Well Depth: \_\_\_\_\_ Depth to Water: \_\_\_\_\_ Well Diameter: \_\_\_\_\_

Casing Material.: \_\_\_\_\_ Volume Of Water per Well Volume: \_\_\_\_\_

Sampling Crew: \_\_\_\_\_

Type of Pump: \_\_\_\_\_ Tubing Material: \_\_\_\_\_ Pump set at \_\_\_\_\_ ft.

Weather Conditions: \_\_\_\_\_ NOTES: \_\_\_\_\_

**GROUND-WATER SAMPLING PARAMETERS**

Time	Water Level	Volume Pumped	Pumping Rate	DO (mg/l)	Temp. (°C)	SEC (µS/cm)	pH	ORP (mV)	Turbidity (NTU)
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Other Parameters: \_\_\_\_\_

Sampled at: \_\_\_\_\_ Parameters taken with: \_\_\_\_\_

Sample delivered to \_\_\_\_\_ by \_\_\_\_\_ at \_\_\_\_\_

Sample CRL #: \_\_\_\_\_ OTR #: \_\_\_\_\_ ITR #: \_\_\_\_\_ SAS #: \_\_\_\_\_

Parameters Collected

Number of Bottles

Bottle Lot Number

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____



### Ground Water Sampling Log

**Site Name:** \_\_\_\_\_ **Well #:** \_\_\_\_\_ **Date:** \_\_\_\_\_  
**Well Depth( Ft-BTOC<sup>1</sup>):** \_\_\_\_\_ **Screen Interval(Ft):** \_\_\_\_\_  
**Well Dia.:** \_\_\_\_\_ **Casing Material:** \_\_\_\_\_ **Sampling Device:** \_\_\_\_\_  
**Pump placement(Ft from TOC<sup>2</sup>):** \_\_\_\_\_  
**Measuring Point:** \_\_\_\_\_ **Water level (static)(Ft):** \_\_\_\_\_  
**Water level (pumping)(Ft):** \_\_\_\_\_ **Pump rate(Liter/min):** \_\_\_\_\_  
**Sampling Personnel:** \_\_\_\_\_  
**Other info: (such as sample numbers, weather conditions and field notes)** \_\_\_\_\_

### Water Quality Indicator Parameters

Time	Pumping rates (L/Min)	Water level (ft)	DO (mg/L)	ORP (mv)	SEC <sup>3</sup>	Turb. (NTU)	pH	Temp. (C <sup>o</sup> )	Volume pumped (L)

Type of Samples collected: \_\_\_\_\_

1 casing volume was:

Total volume purged prior to sample collection:

<sup>1</sup>BTOC-Below Top of Casing

<sup>2</sup>TOC-Top of Casing

<sup>3</sup>Specific Electrical Conductance

#### Stabilization Criteria

D.O.	+/- 0.3 mg/l
Turb.	+/- 10%
S.C.	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

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**ATTACHMENT 3**  
**Example Standard Operating Procedure:**

**Standard Operating Procedure for  
Low-Stress (Low Flow)/Minimal Drawdown  
Ground-Water Sample Collection**

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# Standard Operating Procedure for Low-Stress (Low-Flow)/ Minimal Drawdown Ground-Water Sample Collection

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## INTRODUCTION

The collection of "representative" water samples from wells is neither straightforward nor easily accomplished. Ground-water sample collection can be a source of variability through differences in sample personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at ground-water monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample-collection procedures.

The purpose of this standard operating procedure (SOP) is to provide a method that minimizes the impact the purging process has on the ground-water chemistry and the volume of water that is being purged and disposed of during sample collection. This will take place by placing the pump intake within the screen interval and by keeping the drawdown at a minimal level (0.33 feet) (Puls and Barcelona, 1996) until the water quality parameters have stabilized and sample collection is complete. The flow rate at which the pump will be operating will depend upon both hydraulic conductivity of the aquifer and the drawdown with the goal of minimizing the drawdown. The flow rate from the pump during purging and sampling will be at a rate that will not compromise the integrity of the analyte that is being sampled. This sampling procedure may or may not provide a discrete ground-water sample at the location of the pump intake. The flow of ground-water to the pump intake will be dependent on the distribution of the hydraulic conductivity (K) of the aquifer within the screen interval. In order to minimize the drawdown in the monitoring well, a low-flow rate must be used. "Low-Flow" refers to the velocity with which water enters the pump intake from the surrounding formation in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface, which can be affected by flow regulators or restrictions (Puls and Barcelona, 1996). This SOP was developed by the Superfund/RCRA Ground Water Forum and draws from an USEPA's Ground Water Issue Paper, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedure, by Robert W. Puls and Michael J. Barcelona. Also, available USEPA Regional SOPs

regarding Low-Stress (Low-Flow) Purging and Sampling were used for this SOP.

## SCOPE AND APPLICATION

This SOP should be used primarily at monitoring wells that have a screen or an open interval with a length of ten feet or less and can accept a sampling device that minimizes the disturbance to the aquifer or the water column in the well casing. The screen or open interval should have been optimally located to intercept an existing contaminant plume(s) or along flowpaths of potential contaminant releases. Knowledge of the contaminant distribution within the screen interval is highly recommended and is essential for the success of this sampling procedure. The ground-water samples that are collected using this procedure are acceptable for the analyses of ground-water contaminants that may be found at Superfund and RCRA contamination sites. The analytes may be volatile, semi-volatile organic compounds, pesticides, PCBs, metals, and other inorganic compounds. The screened interval should be located within the contaminant plume(s) and the pump intake should be placed at or near the known source of the contamination within the screened interval. It is critical to place the pump intake in the exact location or depth for each sampling event. This argues for the use of dedicated, permanently installed, sampling devices whenever possible. If this is not possible, then the placement of the pump intake should be positioned with a calibrated sampling pump hose sounded with a weighted-tape or using a pre-measured hose. The pump intake should not be placed near the bottom of the screened interval to avoid disturbing any sediment that may have settled at the bottom of the well.

Water-quality-indicator parameters and water levels must be measured during purging, prior to sample collection. Stabilization of the water-quality-indicator parameters as well as monitoring water levels are a prerequisite to sample collection. The water-quality-indicator parameters that are recommended include the following: specific electrical conductance, dissolved oxygen, turbidity, oxidation-reduction potential, pH, and temperature. The latter two parameters are useful data, but are generally insensitive as purging parameters. Oxidation-reduction potential may not always be appropriate stabilization parameter, and will depend on site-specific conditions. However, readings

should be recorded because of its value as a double check for oxidation conditions and for fate and transport issues.

Also, when samples are collected for metals, semi-volatile organic compounds, and pesticides, every effort must be made to reduce turbidity to 10 NTUs or less (not just the stabilization of turbidity) prior to the collection of the water sample. In addition to the measurement of the above parameters, depth to water must be measured during purging (U.S. Environmental Protection Agency, 1995).

Proper well construction, development, and maintenance are essential for any ground-water sampling procedure. Prior to conducting the field work, information on the construction of the well and well development should be obtained and that information factored into the site specific sampling procedure. The Sampling Checklist at the end of this attachment is an example of the type of information that is useful.

Stabilization of the water-quality-indicator parameters is the criterion for sample collection. But if stabilization is not occurring and the procedure has been strictly followed, then sample collection can take place once three (minimum) to six (maximum) casing volumes have been removed (Schuller et al., 1981 and U.S. Environmental Protection Agency., 1986; Wilde et al., 1998; Gibs and Imbrigiotta., 1990). The specific information on what took place during purging must be recorded in the field notebook or in the ground-water sampling log.

This SOP is not to be used where non-aqueous phase liquids (NAPL) (immiscible fluids) are present in the monitoring well.

## EQUIPMENT

- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of 0.01 foot. Interface probe for determination of liquid products (NAPL) presence, if needed.
- Steel tape and weight - Used for measuring total depth of well. Lead weight should not be used.
- Sampling pump - Submersible or bladder pumps with adjustable rate controls are preferred. Pumps are to be constructed of inert materials, such as

stainless steel and Teflon®. Pump types that are acceptable include gear and helical driven, centrifugal (low-flow type), and air-activated piston. An adjustable rate, peristaltic pump can be used when the depth to water is 20 feet or less.

- Tubing - Teflon® or Teflon®-lined polyethylene tubing is preferred when sampling for organic compounds. Polyethylene tubing can be used when sampling inorganics.
- Power source - If a combustion type (gasoline or diesel-driven) generator is used, it must be placed downwind of the sampling area.
- Flow measurement supplies - flow meter, graduated cylinder, and a stop watch.
- Multi-parameter meter with flow-through cell - This can be one instrument or more contained in a flow-through cell. The water-quality-indicator parameters that are monitored are pH, ORP/Eh, (ORP) dissolved oxygen (DO), turbidity, specific conductance, and temperature. Turbidity readings must be collected before the flow cell because of the potential for sediment buildup, which can bias the turbidity measurements. Calibration fluids for all instruments should be NIST-traceable and there should be enough for daily calibration throughout the sampling event. The inlet of the flow cell must be located near the bottom of the flow cell and the outlet near the top. The size of the flow cell should be kept to a minimum and a closed cell is preferred. The flow cell must not contain any air or gas bubbles when monitoring for the water-quality-indicator parameters.
- Decontamination supplies - Including a reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap will also be needed.
- Sample bottles, sample preservation supplies, sample tags or labels, and chain-of-custody forms.
- Approved Field Sampling and Quality Assurance Project Plan.
- Well construction, field, and water quality data from the previous sampling event.
- Well keys and map of well locations.
- Field notebook, ground-water sampling logs, and calculator. A suggested field data sheet (ground-water sampling record or ground-water sampling log) are provided at the end of this attachment.

- Filtration equipment, if needed. An in-line disposable filter is recommended.
- Polyethylene sheeting placed on ground around the well head.
- Personal protective equipment as specified in the site Health and Safety Plan.
- Air monitoring equipment as specified in the Site Health and Safety Plan.
- Tool box - All needed tools for all site equipment used.
- A 55-gallon drum or container to contain the purged water.

Construction materials of the sampling equipment (bladders, pumps, tubing, and other equipment that comes in contact with the sample) should be limited to stainless steel, Teflon®, glass, and other inert material. This will reduce the chance that sampling materials alter the ground-water where concentrations of the site contaminants are expected to be near the detection limits. The sample tubing diameter should be maximized and the tubing length should be minimized so that the loss of contaminants into and through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of material makes the appropriate selection of sample tubing material critical for trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998).

## **PURGING AND SAMPLING PROCEDURES**

The following describes the purging and sampling procedures for the Low-Stress (Low-Flow)/ Minimal Drawdown method for the collection of ground-water samples. These procedures also describe steps for dedicated and non-dedicated systems.

**Pre-Sampling Activities (Non-dedicated and dedicated system)**

1. Sampling must begin at the monitoring well with the least contamination, generally up-gradient or farthest from the site or suspected source. Then proceed systematically to the monitoring wells with the most contaminated ground water.
2. Check and record the condition of the monitoring well for damage or evidence of tampering. Lay out polyethylene sheeting around the well to minimize the

likelihood of contamination of sampling/purging equipment from the soil. Place monitoring, purging and sampling equipment on the sheeting.

3. Unlock well head. Record location, time, date, and appropriate information in a field logbook or on the ground-water sampling log (See attached ground-water sampling record and ground-water sampling log as examples).

4. Remove inner casing cap.

5. Monitor the headspace of the monitoring well at the rim of the casing for volatile organic compounds (VOC) with a photo-ionization detector (PID) or flame ionization detector (FID) and record in the logbook. If the existing monitoring well has a history of positive readings of the headspace, then the sampling must be conducted in accordance with the Health and Safety Plan.

6. Measure the depth to water (water level must be measured to nearest 0.01 feet) relative to a reference measuring point on the well casing with an electronic water level indicator or steel tape and record in logbook or ground-water sampling log. If no reference point is found, measure relative to the top of the inner casing, then mark that reference point and note that location in the field logbook. Record information on depth to ground water in the field logbook or ground-water sampling log. Measure the depth to water a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

7. Check the available well information or field information for the total depth of the monitoring well. Use the information from the depth of water in step six and the total depth of the monitoring well to calculate the volume of the water in the monitoring well or the volume of one casing. Record information in field logbook or ground-water sampling log.

## **Purging and Sampling Activities**

- 8A. Non-dedicated system - Place the pump and support equipment at the wellhead and slowly lower the pump and tubing down into the monitoring well until the location of the pump intake is set at a pre-determined location within the screen interval. The placement of the pump intake should be positioned

with a calibrated sampling pump hose, sounded with a weighted-tape, or using a pre-measured hose. Refer to the available monitoring well information to determine the depth and length of the screen interval. Measure the depth of the pump intake while lowering the pump into location. Record pump location in field logbook or ground-water sampling log.

8B. Dedicated system - Pump has already been installed, refer to the available monitoring well information and record the depth of the pump intake in the field logbook or ground-water sampling log.

9. Non-dedicated system and dedicated systems - Measure the water level (water level must be measured to nearest 0.01 feet) and record information on the ground-water sampling log, leave water level indicator probe in the monitoring well.

10. Non-dedicated and dedicated systems - Connect the discharge line from the pump to a flow-through cell. A "T" connection is needed prior to the flow-through cell to allow for the collection of water for the turbidity measurements. The discharge line from the flow-through cell must be directed to a container to contain the purge water during the purging and sampling of the monitoring well.

11. Non-dedicated and dedicated systems - Start pumping the well at a low flow rate (0.2 to 0.5 liter per minute) and slowly increase the speed. Check water level. Maintain a steady flow rate while maintaining a drawdown of less than 0.33 feet (Puls and Barcelona, 1996). If drawdown is greater than 0.33 feet, lower the flow rate. 0.33 feet is a goal to help guide with the flow rate adjustment. It should be noted that this goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience (Puls and Barcelona, 1996).

12. Non-dedicated and dedicated systems - Measure the discharge

rate of the pump with a graduated cylinder and a stop watch. Also, measure the water level and record both flow rate and water level on the ground-water sampling log. Continue purging, monitor and record water level and pump rate every three to five minutes during purging. Pumping rates should be kept at minimal flow to ensure minimal drawdown in the monitoring well.

13. Non-dedicated and dedicated systems - During the purging, a minimum of one tubing volume (including the volume of water in the pump and flow cell) must be purged prior to recording the water-quality indicator parameters. Then monitor and record the water-quality-indicator parameters every three to five minutes. The water-quality indicator field parameters are turbidity, dissolved oxygen, specific electrical conductance, pH, redox potential, and temperature. Oxidation-reduction potential may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions. Also, for the final dissolved oxygen measurement, if the readings are less than 1 milligram per liter, it should be collected and analyzed with the spectrophotometric method (Wilde et al., 1998 Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). The stabilization criterion is based on three successive readings of the water quality field parameters; the following are the criteria which must be used:

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1 pH units	Puls and Barcelona, 1996; Wilde et al., 1998
specific electrical conductance (SEC)	+/- 3% S/cm	Puls and Barcelona, 1996
oxidation-reduction potential (ORP)	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% NTUs (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen	+/- 0.3 milligrams per liter	Wilde et al., 1998

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Once the criteria have been successfully met indicating that the water quality indicator parameters have stabilized, then sample collection can take place.

14. If a stabilized drawdown in the well can't be maintained at 0.33 feet and the water level is approaching the top of the screened interval, reduce the flow rate or turn the pump off (for 15 minutes) and allow for recovery. It should be noted whether or not the pump has a check valve. A check valve is required if the pump is shut off. Under no circumstances should the well be pumped dry. Begin pumping at a lower flow rate, if the water draws down to the top of the screened interval again, turn pump off and allow for recovery. If two tubing volumes (including the volume of water in the pump and flow cell) have been removed during purging, then sampling can proceed next time the pump is turned on. This information should be noted in the field notebook or ground-water sampling log with a recommendation for a different purging and sampling procedure.

15. Non-dedicated and dedicated systems - Maintain the same pumping rate or reduce slightly for sampling (0.2 to 0.5 liter per minute) in order to minimize disturbance of the water column. Samples should be collected directly from the discharge port of the pump tubing prior to passing through the flow-through cell. Disconnect the pump's tubing from the flow-through cell so that the samples are collected from the pump's discharge tubing. For samples collected for dissolved gases or VOC analyses, the pump tubing needs to be completely full of ground water to prevent the ground water from being aerated as it flows through the tubing. The sequence of the samples is immaterial unless filtered (dissolved) samples are collected and they must be collected last (Puls and Barcelona, 1996). All sample containers should be filled with minimal turbulence by allowing the ground water to flow from the tubing gently down the inside of the container. When filling the VOC samples, a meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and head space prior to capping. In the event that the ground water is turbid, (greater than 10 NTUs), a filtered metal (dissolved) sample also should be collected.

If filtered metal sample is to be collected, then an in-line filter is fitted at the end of the discharge tubing and the sample is collected after the filter. The in-line

filter must be pre-rinsed following manufacturer's recommendations and if there are no recommendations for rinsing, a minimum of 0.5 to 1 liter of ground water from the monitoring well must pass through the filter prior to sampling.

16A. Non-dedicated system - Remove the pump from the monitoring well. Decontaminate the pump and dispose of the tubing if it is non-dedicated.

16B. Dedicated system - Disconnect the tubing that extends from the plate at the wellhead (or cap) and discard after use.

17. Non-dedicated system - Before locking the monitoring well, measure and record the well depth (to 0.1 feet).

Measure the total depth a second time to confirm initial measurement; measurement should agree within 0.01 feet or re-measure.

18. Non-dedicated and dedicated systems - Close and lock the well.

## DECONTAMINATION PROCEDURES

Decontamination procedures for the water level meter and the water quality field parameter sensors. The electronic water level indicator probe/steel tape and the water-quality field parameter sensors will be decontaminated by the following procedures:

1. The water level meter will be hand washed with phosphate-free detergent and a scrubber, then thoroughly rinsed with distilled water.
2. Water quality field parameter sensors and flow-through cell will be rinsed with distilled water between sampling locations. No other decontamination procedures are necessary or recommended for these probes since they are sensitive. After the sampling event, the flow cell and sensors must be cleaned and maintained per the manufacturer's requirements.

### Decontamination Procedure for the Sampling Pump

Upon completion of the ground water sample collection the sampling pump must be properly decontaminated between monitoring wells. The pump and discharge line including support cable and electrical



wires which were in contact with the ground water in the well casing must be decontaminated by the following procedure:

1. The outside of the pump, tubing, support cable and electrical wires must be pressure-sprayed with soapy water, tap water, and distilled water. Spray outside of tubing and pump until water is flowing off of tubing after each rinse. Use bristle brush to help remove visible dirt and contaminants.
2. Place the sampling pump in a bucket or in a short PVC casing (4-in. diameter) with one end capped. The pump placed in this device must be completely submerged in the water. A small amount of phosphate-free detergent must be added to the potable water (tap water).
3. Remove the pump from the bucket or 4-in. casing and scrub the outside of the pump housing and cable.
4. Place pump and discharge line back in the 4-in. casing or bucket, start pump and recirculate this soapy water for 2 minutes (wash).
5. Re-direct discharge line to a 55-gallon drum. Continue to add 5 gallons of potable water (tap water) or until soapy water is no longer visible.
6. Turn pump off and place pump into a second bucket or 4-in. casing that contains tap water. Continue to add 5 gallons of tap water (rinse).
7. Turn pump off and place pump into a third bucket or 4-in. casing which contains distilled/deionized water, continue to add 3 to 5 gallons of distilled/deionized water (final rinse).
8. If a hydrophobic contaminant is present (such as separate phase, high levels of PCBs, etc.), an additional decontamination step, or steps, may be added. For example, an organic solvent, such as reagent-grade isopropanol alcohol may be added as a first spraying/bucket prior to the soapy water rinse/bucket.

#### FIELD QUALITY CONTROL

Quality control (QC) samples must be collected to verify that sample collection and handling procedures were performed adequately and that they have not compromised the quality of the ground-water samples. The appropriate EPA program guidance must be consulted in preparing the field QC sample requirements for the site-specific Quality Assurance Project Plan (QAPP).

There are five primary areas of concern for quality assurance (QA) in the collection of representative ground-water samples:

1. Obtaining a ground-water sample that is representative of the aquifer or zone of interest in the aquifer. Verification is based on the field log documenting that the field water-quality parameters stabilized during the purging of the well, prior to sample collection.
2. Ensuring that the purging and sampling devices are made of materials, and utilized in a manner that will not interact with or alter the analyses.
3. Ensuring that results generated by these procedures are reproducible; therefore, the sampling scheme should incorporate co-located samples (duplicates).
4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling and purging equipment, and decontamination of the equipment is therefore required.
5. Properly preserving, packaging, and shipping samples.

All field QC samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The chain-of-custody procedures for the QC samples will be identical to the field ground-water samples. The following are QC samples that must be collected during the sampling event:

Sample Type	Frequency
• Field duplicates	1 per 20 samples
• Matrix spike	1 per 20 samples
• Matrix spike duplicate	1 per 20 samples
• Equipment blank	per Regional requirements or policy
• Trip blank (VOCs)	1 per sample cooler
• Temperature blank	1 per sample cooler

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## HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site Health and Safety Plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phase through the use of appropriate personal protective equipment.

Depending on the type of contaminants expected or determined in previous sampling efforts, the following safe work practices will be employed:

### Particulate or metals contaminants

1. Avoid skin contact with, and incidental ingestion of, purge water.
2. Use protective gloves and splash protection.

### Volatile organic contaminants

1. Avoid breathing constituents venting from well.
2. Pre-survey the well head space with an appropriate device as specified in the site Health and Safety Plan.
3. If monitoring results indicate elevated organic constituents, sampling activities may be conducted in level C protection. At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®.

General practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when filling pre-acidified VOA bottles, hydrochloric acid fumes may be released and should not be inhaled.

## POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to the following:

1. Ensuring that all field equipment has been decontaminated and returned to proper storage location.

Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.

2. Processing all sample paperwork, including copies provided to the Regional Laboratory, Sample Management Office, or other appropriate sample handling and tracking facility.
3. Compiling all field data for site records.
4. Verifying all analytical data processed by the analytical laboratory against field sheets to ensure all data has been returned to sampler.

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Well Identification:

Map of Site Included: Y or N

Wells Clearly Identified with Roads: Y or N

Well Construction Diagram Attached: Y or N

### Well Construction:

Diameter of Borehole: \_\_\_\_\_ Diameter of Casing: \_\_\_\_\_

Casing Material: \_\_\_\_\_ Screen Material: \_\_\_\_\_

Screen Length: \_\_\_\_\_ Total Depth: \_\_\_\_\_

Approximate Depth to Water:

Maximum Well Development Pumping Rate: \_\_\_\_\_

Date of Last Well Development: \_\_\_\_\_

**Previous Sampling Information:**

Was the Well Sampled Previously: Y or N

(If Sampled, Fill Out Table Below)

[illegible]

### Ground Water Sampling Log

**Site Name:** \_\_\_\_\_ **Well #:** \_\_\_\_\_ **Date:** \_\_\_\_\_  
**Well Depth( Ft-BTOC<sup>1</sup>):** \_\_\_\_\_ **Screen Interval(Ft):** \_\_\_\_\_  
**Well Dia.:** \_\_\_\_\_ **Casing Material:** \_\_\_\_\_ **Sampling Device:** \_\_\_\_\_  
**Pump placement(Ft from TOC<sup>2</sup>):** \_\_\_\_\_  
**Measuring Point:** \_\_\_\_\_ **Water level (static)(Ft):** \_\_\_\_\_  
**Water level (pumping)(Ft):** \_\_\_\_\_ **Pump rate(Liter/min):** \_\_\_\_\_  
**Sampling Personnel:** \_\_\_\_\_  
**Other info: (such as sample numbers, weather conditions and field notes)** \_\_\_\_\_

### Water Quality Indicator Parameters

Time	Pumping rates (L/Min)	Water level (ft)	DO (mg/L)	ORP (mv)	Turb. (NTU)	SEC <sup>3</sup> (S/cm)	pH	Temp. (C <sup>0</sup> )	Volume pumped (L)

**Type of Samples collected:** \_\_\_\_\_

**1 casing volume was:** \_\_\_\_\_

**Total volume purged prior to sample collection:** \_\_\_\_\_

<sup>1</sup>BTOC-Below Top of Casing

<sup>2</sup>TOC-Top of Casing

<sup>3</sup>Specific Electrical Conductance

#### Stabilization Criteria

D.O.	+/- 0.3 mg/l
Turb.	+/- 10%
S.C.	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

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**ATTACHMENT 4**  
**Example Standard Operating Procedure:**

**Standard Operating Procedure for  
the Standard/Well-Volume Method for  
Collecting a Ground-Water Sample**

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# Standard Operating Procedure for the Well-Volume Method for Collecting a Ground-Water Sample

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## INTRODUCTION

The collection of "representative" water samples from wells is neither straightforward nor easily accomplished. Ground-water sample collection can be a source of variability through differences in sampling personnel and their individual sampling procedures, the equipment used, and ambient temporal variability in subsurface and environmental conditions. Many site inspections and remedial investigations require the sampling at ground-water monitoring wells within a defined criterion of data confidence or data quality, which necessitates that the personnel collecting the samples are trained and aware of proper sample-collection procedures.

The objectives of the sampling procedures described in this document are to minimize changes in ground-water chemistry during sample collection and transport to the laboratory and to maximize the probability of obtaining a representative, reproducible ground-water sample. Sampling personnel may benefit from a working knowledge of the chemical processes that can influence the concentration of dissolved chemical species.

The well-volume method described in this standard operating procedure (SOP) provides a reproducible sampling technique with the goal that the samples obtained will represent water quality over an entire open interval of a short-screened (ten feet or less) well. This technique is appropriate for long-term and detection monitoring of formation water quality. The resulting sample generally represents a composite of the screened interval, and thus integrates small-scale vertical heterogeneities of ground-water chemistry. This sampling technique also is useful for screening purposes for detection monitoring of contaminants in the subsurface. However, the detection of a low concentration of contaminant in a thin contaminated zone or with long well screens may be difficult and should be determined using detailed vertical profiling techniques.

This method may not be applicable for all ground-water-sampling wells, such as wells with very low yields, fractured rock, and some wells with turbidity problems. As always, site-specific conditions and objectives should be considered prior to the selection of this method for sampling.

## SCOPE AND APPLICATION

The objective of a good sampling program should be the collection of a representative sample of the current ground-water conditions over a known or specified volume of aquifer. To meet this objective, the sampling equipment, the sampling method, the monitoring well construction, monitoring well operation and maintenance, and sample-handling procedures should not alter the chemistry of the sample.

An example of how a site's Data Quality Objectives (DQOs) for a characterization sampling effort might vary from those of a remediation monitoring sampling effort could be a difference of how much of the screened interval or aquifer should be sampled. A site characterization objective may be to collect a sample that represents a composite of the entire (or as close as is possible) screened interval of the monitoring well.

Additionally, the site characterization may require a large suite of contaminants to be sampled and analyzed, whereas, the remediation monitoring program may require fewer contaminants sampled and analyzed. These differences may dictate the type of sampling equipment used, the type of information collected, and the sampling protocol.

This sampling method described is for monitoring wells. However, this method should not be used for water-supply wells with a water-supply pump, with long-screened wells in complex hydrogeologic environments (such as fractured rock), or wells with separate phases of liquids (such as a Dense or Light Non-Aqueous Phase Liquids) present within the screened interval.

## EQUIPMENT

- Depth-to-water measuring device - An electronic water-level indicator or steel tape and chalk, with marked intervals of 0.01 foot. Interface probe for measuring separate phase liquids, if needed. Pressure transducer and data logger optional for frequent depth-to-water measuring in same well.
- Steel tape and weight - Used for measuring total depth of well. Lead weights should not be used.
- Sampling pump - Submersible or bladder pumps with adjustable rate controls are preferred. Pumps



are to be constructed of inert materials, such as stainless steel and Teflon®. Pump types that are acceptable include gear and helical driven, centrifugal (low-flow type), and air-activated piston. Adjustable rate, peristaltic pumps can be used when the depth to water is 20 feet or less.

- **Tubing** - Inert tubing should be chosen based on the types and concentrations of contaminants present, or expected to be present in the monitoring well. Generally, Teflon®-based tubing is recommended when sampling for organic compounds. Polyethylene or Teflon® tubing can be used when sampling for inorganic constituents.
- **Power source** - If a combustion type (gasoline or diesel-driven) device is used, it must be located downwind of the point of sample collection. If possible, it should also be transported to the site and sampling location in a different vehicle from the sampling equipment.
- **Flow-measurement equipment** - Graduated cylinder or bucket and a stop watch, or a flow meter that can be disconnected prior to sampling.
- **Multi-parameter meter with flow-through cell** - This can be one instrument or multiple probes/instruments contained in a flow-through cell. The water-quality-indicator parameters that are measured in the field are pH, oxidation/reduction potential (ORP, redox, or Eh), dissolved oxygen (DO), turbidity, specific electrical conductance (SEC), and temperature. Calibration standards for all instruments should be NIST-traceable, within expiration dates of the solutions, and sufficient for daily calibration throughout the sampling collection.
- **Decontamination supplies** - A reliable and documented source of distilled water and any solvents (if used). Pressure sprayers, buckets or decontamination tubes for pumps, brushes and non-phosphate soap also will be needed.
- **Sample bottles, sample preservation supplies and laboratory paperwork.** Also, several coolers, and sample packing supplies (absorbing packing material, plastic baggies, etc.).
- **Approved plans and background documents** - Approved Field Sampling Plan, Quality Assurance Project Plan, well construction data, field and water-quality data from the previous sampling collection.
- **Site Access/Permission documentation** for site entry.

- **Well keys and map** showing locations of wells.
- **Field notebook, field data sheets and calculator.** A suggested field data sheet is provided at the end of this attachment.
- **Filtration equipment** - If needed, this equipment should be an in-line disposable filter used for the collection of samples for analysis of dissolved constituents.
- **Polyethylene sheeting** - Used for decontamination stations and during sampling to keep equipment clean.
- **Site Health and Safety Plan and required equipment** - The health and safety plan along with site sign-in sheet should be on site and be presented by the site health and safety officer. Personnel-protective and air-monitoring equipment specified in the Site Health and Safety Plan should be demonstrated, present and in good working order on site at all times.
- **Tool box** - All needed tools for all site equipment used.
- **A 55-gallon drum or container** to contain the purged water.

Construction materials of the sampling equipment (bladders, pump, bailers, tubing, etc.) should be limited to stainless steel, Teflon®, glass, and other inert materials when concentrations of the site contaminants are expected within the detection limit range. The sample tubing thickness and diameter should be maximized and the tubing length should be minimized so that the loss of contaminants absorbed to and through the tubing walls may be reduced and the rate of stabilization of ground-water parameters is maximized. The tendency of organics to sorb into and out of many materials makes the appropriate selection of sample tubing materials critical for these trace analyses (Pohlmann and Alduino, 1992; Parker and Ranney, 1998).

Generally, wells should be purged and sampled using the same positive-displacement pump and/or a low-flow submersible pump with variable controlled flow rates and constructed of chemically inert materials. If a pump cannot be used because the recovery rate of the well is so low (less than 100 to 200 ml/min) and the volume of the water to be removed is minimal (less than 5 feet of water in a small-diameter well), then a Teflon® bailer, with a double check valve and bottom-emptying device with a control-flow check

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valve may be used to obtain the samples. Otherwise, a bailer should not be used when sampling for volatile organics because of the potential bias introduced during sampling (Yeskis et al., 1988; Pohlmann et al., 1990; Tai et al., 1991). Bailers also should be avoided when sampling for metals because repeated bailer deployment has the potential to increase turbidity, which biases concentrations of inorganic constituents. Dedicated sampling pumps are recommended for metals sampling (Puls et al., 1992).

In addition, for wells with long riser pipes above the well screen, the purge volumes may be reduced by using packers above the pumps. The packer materials should be compatible with the parameters to be analyzed. These packers should be used only on wells screened in highly permeable materials, because of the lack of ability to monitor water levels in the packed interval. Otherwise, if pumping rates exceed the natural aquifer recovery rates into the packed zone, a vacuum or negative pressure zone may develop. This may result in a failure of the seal by the packer and/or a gaseous phase may develop, that may bias any sample taken.

## **PURGING AND SAMPLING PROCEDURE**

### **WATER-LEVEL MEASUREMENTS**

The field measurements should include total well depth and depth to water from a permanently marked reference point.

#### **TOTAL WELL DEPTH**

The depth of each well should be measured to the nearest one-tenth of a foot when using a steel tape with a weight attached and should be properly recorded. The steel tape should be decontaminated before use in another well according to the site specific protocols. A concern is that when the steel tape and weight hit the bottom of the well, sediment present on the bottom of a well is stirred up, thus increasing turbidity, which will affect the sampling results. In these cases, as much time as possible should be allowed prior to sampling, such as a minimum of 24 hours. If possible, total well depth measurements can be completed after sampling (Puls and Barcelona, 1996). The weight of electric tapes is generally too light to determine accurate total well depth. If the total well depth is greater than 200 feet, stretching of the tape must be taken into consideration.

#### **DEPTH TO WATER**

All water levels should be measured from the reference point by use of a weighted steel tape and chalk or an electronic water-level indicator (a detailed discussion of the pros and cons of the different water level devices is provided in Thornhill, 1989). The steel tape is a more accurate method to take water levels, and is recommended where shallow flow gradients (less than 0.05 feet/foot) or deep wells are encountered. However, in those cases where large flow gradients or large fluctuations in water levels are expected, a calibrated electric tape is acceptable. The water level is calculated using the well's surveyed reference point minus the measured depth-to-water and should be measured to the nearest one hundredth of a foot.

The depth-to-water measurement must be made in each well to be sampled prior to any other activities at the well (such as bailing, pumping, and hydraulic testing) to avoid bias to the measurement. All readings are to be recorded to the nearest one hundredth of a foot. When possible, depth-to-water and total well depth measurements should be completed at the beginning of a ground-water sampling program, which will allow any turbidity to settle and allow a more synoptic water-level evaluation. However, if outside influences (such as tidal cycles, nearby pumping effects, or major barometric changes) may result in significant water-level changes in the time between measurement and sampling, a water-level measurement should be completed immediately prior to sampling. In addition, the depth-to-water measurement during purging should be recorded, with the use of a pressure transducer and data logger sometimes more efficient (Barcelona et al., 1985, Wilde et al., 1998).

The time and date of the measurement, point of reference, measurement method, depth-to-water measurement, and any calculations should be properly recorded in field notebook or sampling sheet.

#### **STATIC WATER VOLUME**

From the information obtained for casing diameter, total well depth and depth-to-water measurements, the volume of water in the well is calculated. This value is one criteria that may be used to determine the volume of water to be purged from the well before the sample is collected.

The static water volume may be calculated using the following formula:

$$V = r^2h(0.163)$$

Where:

V	=	static volume of water in well (in gallons)
r	=	inner radius of well casing (in inches)
h	=	length of water column (in feet) which is equal to the total well depth minus depth to water.
0.163	=	a constant conversion factor that compensates for the conversion of the casing radius from inches to feet for 2-inch diameter wells and the conversion of cubic feet to gallons, and pi ( $\pi$ ). This factor would change for different diameter wells.

Static water volumes also may be obtained from various sources, such as Appendix 11.L in Driscoll (1986).

## WELL PURGING

### PURGE VOLUMES

In most cases, the standing water in the well casing can be of a different chemical composition than that contained in the aquifer to be sampled. Solutes may be adsorbed or desorbed from the casing material, oxidation may occur, and biological activity is possible. Therefore, the stagnant water within the well must be purged so that water that is representative of the aquifer may enter the well.

The removal of at least three well volumes is suggested (USEPA, 1986; Wilde et al., 1998). The amount of water removed may be determined by collecting it in a graduated pail of known volume to determine pumping rate and time of pumping. A flow meter may also be used, as well as capturing all purged water in a container of known volume.

The actual number of well volumes to be removed is based on the stabilization of water-quality-indicator parameters of pH, ORP, SEC, DO, and turbidity. The

water initially pumped is commonly turbid. In order to keep the turbidity and other probes from being clogged with the sediment from the turbid water, the flow-through cell should be bypassed initially for the first well volume. These measurements should be taken and recorded every  $\frac{1}{2}$  well volume after the removal of 1 to 1  $\frac{1}{2}$  well volume(s). Once three successive readings of the water-quality-indicator parameters provided in the table have stabilized, sampling may begin. The water-quality-indicator parameters that are recommended include pH and temperature, but these are generally insensitive to indicate completion of purging since they tend to stabilize rapidly (Puls and Barcelona, 1996). ORP may not always be an appropriate stabilization parameter, and will depend on site-specific conditions. However, readings should be recorded because of its value as a double check for oxidizing conditions, and for some fate and transport issues. When possible, especially when sampling for contaminants that may be biased by the presence of turbidity, the turbidity reading is desired to stabilize at a value below 10 Nephelometric Turbidity Units (NTUs). For final DO measurements, if the readings are less than 1 milligram per liter, they should be collected with the spectrophotometric method (Wilde et al., 1998, Wilkin et al., 2001), colorimetric or Winkler titration (Wilkin et al., 2001). All of these water-quality-indicator parameters should be evaluated against the specifications of the accuracy and resolution of the instruments used. No more than six well volumes should be purged, to minimize the over pumping effects described by Gibs and Imbrigiotta (1990).

### Purging Methods

In a well that is not being pumped, there will be little or no vertical mixing in the water column between sampling events, and stratification may occur. The water in the screened section may mix with the ground water due to normal flow patterns, but the water above the screened section will remain isolated and become stagnant. Persons sampling should realize that stagnant water may contain foreign material inadvertently or deliberately introduced from the surface, resulting in unrepresentative water quality. To safeguard against collecting nonrepresentative stagnant water in a sample, the following guidelines and techniques should be adhered to during sample collection:

**Table of Stabilization Criteria with References for Water-Quality-Indicator Parameters**

Parameter	Stabilization Criteria	Reference
pH	+/- 0.1	Puls and Barcelona, 1996; Wilde et al., 1998
<b>specific electrical conductance (SEC)</b>	+/- 3%	Puls and Barcelona, 1996
<b>oxidation-reduction potential (ORP)</b>	+/- 10 millivolts	Puls and Barcelona, 1996
turbidity	+/- 10% (when turbidity is greater than 10 NTUs)	Puls and Barcelona, 1996; Wilde et al., 1998
dissolved oxygen (DO)	+/- 0.3 milligrams per liter	Wilde et al., 1998

1. As a general rule, monitoring wells should be pumped or bailed (although bailing is to be strongly avoided) prior to collecting a sample. Evacuation of a minimum of three volumes of water in the well casing is recommended for a representative sample. In a high-yielding ground-water formation where there is no stagnant water in the well above the screened section (commonly referred to as a water-table well), evacuation prior to sample withdrawal is not as critical but serves to field rinse and condition sampling equipment. The purge criteria has been described previously and will be again in the SAMPLING PROCEDURES section on the following page. The rate of purging should be at a rate and by a method that does not cause aeration of the water column and should not exceed the rate at which well development was completed.

2. For wells that can be pumped or bailed to dryness with the sampling equipment being used, the well should be evacuated to just above the well screen interval and allowed to recover prior to sample withdrawal. (Note: It is important not to completely de-water the zone being sampled, as this may allow air into that zone which could result in negative bias in organic and metal constituents.) If the recovery rate is fairly rapid and time allows, evacuation of more than one volume of water is preferred.

3. A non-representative sample also can result from excessive prepumping of the monitoring well. Stratification of the contaminant concentrations in the ground-water formation may occur or heavier-than-water compounds may sink to the lower portions of

the aquifer. Excessive pumping can decrease or increase the contaminant concentrations from what is representative of the sampling point of interest, as well as increase turbidity and create large quantities of waste water.

The method used to purge a well depends on the inner diameter, depth-to-water level, volume of water in the well, recovery rate of the aquifer, and accessibility of the well to be sampled. The types of equipment available for well evacuation include hand-operated or motor-driven suction pumps, peristaltic pumps, submersible pumps, and bailers made of various materials, such as stainless steel and Teflon®. Whenever possible, the same device used for purging the well should be left in the well and used for sampling, generally in a continual manner from purging directly to sampling without altering position of the sampling device or turning off the device.

When purging/sampling equipment must be reused in other wells, it should be decontaminated consistent with the decontamination procedures outlined in this document. Purged water should be collected and screened with air-monitoring equipment as outlined in the site health and safety plan, as well as water-quality field instruments. If these parameters and/or the facility background data suggest that the water is hazardous, it should be contained and disposed of properly as determined on a site-specific basis.

During purging, water-level measurements should be recorded regularly for shallow wells, typically at 15- to 30-second intervals. These data may be useful in

computing aquifer transmissivity and other hydraulic characteristics, and for adjusting purging rates. In addition, these data will assure that the water level doesn't fall below the pump intake level

## SAMPLING PROCEDURES

Ground-water sample collection should take place immediately following well purging. Preferably, the same device should be used for sample collection as was used for well purging, minimize further disturbance of the water column, and reduce volatilization and turbidity. In addition, this will save time and avoid possible contamination from the introduction of additional equipment into the well, as well as using equipment materials already equilibrated to the ground water. Sampling should occur in a progression from the least to most contaminated well, if known, when the same sampling device is used.

The sampling procedure is as follows:

- 1) Remove locking well cap. Note location, time of day, and date in field notebook or on an appropriate log form.
- 2) Note wind direction. Stand upwind from the well to avoid contact with gases/vapors emanating from the well.
- 3) Remove well casing cap.
- 4) If required by site-specific conditions, monitor headspace of well with appropriate air-monitoring equipment to determine presence of volatile organic compounds or other compounds of concern and record in field logbook.
- 5) If not already completed, measure the water level from the reference measuring point on the well casing or protective outer casing (if inner casing not installed or inaccessible) and record it in the field notebook. Alternatively, if no reference point exists, note that the water level measurement is from the top of the outer protective casing, top of inside riser pipe, ground surface, or some other position on the well head. Have a permanent reference point established as soon as possible after sampling. Measure at least twice to confirm measurement; the measurement should agree within 0.01 feet or re-measure. Decontaminate the water-level-measuring device.

- 6) If not already completed, measure the total depth of the well (at least twice to confirm measurement; the measurement should agree within 0.01 feet or re-measure) and record it in the field notebook or on log form. Decontaminate the device used to measure total depth. If the total well depth has been measured recently (in the past year), then measure it at the conclusion of sampling.
- 7) Calculate the volume of water in the well and the volume to be purged using the formula previously provided.
- 8) Lay plastic sheeting around the well to minimize the likelihood of contamination of equipment from soil adjacent to the well.
- 9) Rinse the outside of sampling pump with distilled water and then, while lowering the pump, dry it with disposable paper towels.
- 10) Lower the pump (or bailer) and tubing down the well. The sampling equipment should never be dropped into the well because this will cause degassing of the water upon impact. This may also increase turbidity, which may bias the metals analysis. The lowering of the equipment should be slow and smooth!
- 11) The pump should be lowered to a point just below the water level. If the water level is above the screened interval, the pump should be above the screened interval for the reasons provided in the purging section.
- 12) Turn the pump on. The submersible pumps should be operated in a continuous, low-flow manner so that they do not produce pulsating flows, which cause aeration in the discharge tubing, aeration upon discharge, or resuspension of sediments at the bottom of the well. The sampling pump flow rates should be lower than or the same as the purging rates. The purging and sampling rates should not be any greater than well development rates.
- 13) Water levels should be monitored during pumping to ensure that air does not enter the pump and to help determine an appropriate purging rate.
- 14) After approximately one to two well volumes are removed, a flow-through cell will be hooked up to the discharge tubing of the pump. If the

- well discharge water is not expected to be highly turbid, contain separate liquid phases, or minimal bacterial activity that may coat or clog the electrodes within the flow-through cell, then the cell can be immediately hooked up to the discharge tubing. This cell will allow measurements of water-quality-indicator parameters without allowing contact with the atmosphere prior to recording the readings for temperature, pH, ORP, SEC, DO and turbidity.
- 15) Measurements for temperature, pH, ORP, SEC, DO, and turbidity will be made at each one-half well volume removed. Purging may cease when measurements for all five parameters have stabilized (provided in the earlier table) for three consecutive readings.
- 16) If the water level is lowered to the pump level before three volumes have been removed, the water level will be allowed to recover for 15 minutes, and then pumping can begin at a lower flow rate. If the pump again lowers the water level to below the pump intake, the pump will be turned off and the water level allowed to recover for a longer period of time. This will continue until a minimum of two well volumes are removed prior to taking the ground-water sample.
- 17) If the water-quality-indicator parameters have stabilized, sample the well. Samples will be collected by lowering the flow rate to a rate that minimizes aeration of the sample while filling the bottles (approximately 300 ml/min). Then a final set of water-quality-indicator parameters is recorded. The pump discharge line is rapidly disconnected from the flow-through cell to allow filling of bottles from the pump discharge line. The bottles should be filled in the order of volatile organic compounds bottles first, followed by semi-volatile organic compound's/pesticides, inorganics, and other unfiltered samples. Once the last set of samples is taken, if filtering is necessary, an in-line disposable filter (with appropriately chosen filter size) will be added to the discharge hose of the pump. Then the filtered samples will be taken. If a bailer is used for obtaining the samples, filtering occurs at the sampling location immediately after the sample is obtained from the bailer by using a suction filter. The first one-half to one liter of sample taken through the filter will not be collected, in order to assure the filter media is acclimated to the sample. If filtered samples are collected, WITHOUT EXCEPTION, filtering should be performed in the field as soon as possible after collection, and not later in a laboratory.
- 18) All appropriate samples that are to be cooled, are put into a cooler with ice immediately. All of the samples should not be exposed to sunlight after collection. Keep the samples from freezing in the winter when outside temperatures are below freezing. The samples, especially organics, cyanide, nutrients, and other analytes with short holding times, are recommended to be shipped or delivered to the laboratory daily. Ensure that the appropriate samples that are to be cooled remain at 4°C, but do not allow any of the samples to freeze.
- 19) If a pump cannot be used because the recovery rate is slow and the volume of the water to be removed is minimal (less than 5 feet of water), then a Teflon® bailer, with a double check valve and bottom-emptying device with a control-flow check valve will be used to obtain the samples. The polypropylene rope used with the bailer will be disposed of following the completion of sampling at each well.
- 20) The pump is removed from the well and decontaminated for the next sampling location.
- Additional precautions to ensure accurate and representative sample collection are as follows:
- Check valves on bailers, if bailers are used, should be designed and inspected to ensure that fouling problems do not reduce delivery capabilities or result in aeration of the sample.
  - The water should be transferred to a sample container in a way that will minimize agitation and aeration.
  - If the sample bottle contains no preservatives, the bottle should be rinsed with sample water, which is discarded before sampling. Bottles for sample analyses that require preservation should be prepared before they are taken to the well. Care should be taken to avoid overfilling bottles so that the preservative is not lost. The pH should be checked and more preservatives added to inor-

organic sample bottles, if needed. VOA bottles that do not meet the pH requirements need to be discarded and new sample bottles with more preservative added should be prepared immediately.

- Clean sampling equipment should not be placed directly on the ground or other contaminated surfaces either prior to sampling or during storage and transport.

#### Special Consideration for Volatile Organic Compound Sampling

The proper collection of a sample for dissolved volatile organics requires minimal disturbance of the sample to limit volatilization and therefore a loss of volatiles from the samples. Preferred retrieval systems for the collection of un-biased volatile organic samples include positive displacement pumps, low-flow centrifugal pumps, and some in-situ sampling devices. Field conditions and other constraints will limit the choice of appropriate systems. The principal objective is to provide a valid sample for analysis, one that has been subjected to the least amount of turbulence possible.

- 1) Fill each vial to just overflowing. Do not rinse the vial, nor excessively overflow it, as this will effect the pH by diluting the acid preservative previously placed in the bottle. Another option is to add the acid at the well, after the sample has been collected. There should be a convex meniscus on the top of the vial.
- 2) Do not over tighten and break the cap.
- 3) Invert the vial and tap gently. Observe the vial closely. If an air bubble appears, discard the sample and collect another. It is imperative that no entrapped air remains in the sample vial. Bottles with bubbles should be discarded, unless a new sample cannot be collected, and then the presence of the bubble should be noted in the field notes or field data sheet. If an open sample bottle is dropped, the bottle should be discarded.
- 4) Orient the VOC vial in the cooler so that it is lying on its side, not straight up.
- 5) The holding time for VOCs is 14 days. It is recommended that samples be shipped or delivered to the laboratory daily. Ensure that

the samples remain at 4°C, but do not allow the samples to freeze.

#### Field Filtration of Turbid Samples

The USEPA recognizes that in some hydrogeologic environments, even with proper well design, installation, and development, in combination with the low-flow rate purging and sampling techniques, sample turbidity cannot be reduced to ambient levels. The well construction, development, and sampling information should be reviewed by the Regional geologists or hydrologists to see if the source of the turbidity problems can be resolved or if alternative sampling methods should be employed. If the water sample is excessively turbid, the collection of both filtered and unfiltered samples, in combination with turbidity, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pumping rate, and drawdown data is recommended. The filter size used to determine TSS and TDS should be the same as used in the field filtration. An in-line filter should be used to minimize contact with air to avoid precipitation of metals. The typical filter media size used is 0.45 µm because this is commonly accepted as the demarcation between dissolved and non-dissolved species. Other filter sizes may be appropriate, but their use should be determined based on site-specific criteria (examples include grain-size distribution, ground-water flow velocities, mineralogy) and project DQOs. Filter sizes up to 10.0 µm may be warranted because larger size filters may allow particulates that are mobile in ground water to pass through (Puls and Powell, 1992). The changing of filter media size may limit the comparability of the data obtained with other data sets and may affect their use in some geochemical models. Filter media size used on previous data sets from a site, region, or aquifer and the DQOs should be taken into consideration. The filter media used during the ground-water sampling program should be collected in a suitable container and archived because potential analysis of the media may be helpful for the determination of particulate size, mineralogy, etc.

The first 500 to 1000 milliliters of sample taken through the filter, depending on sample turbidity, will not be collected for a sample, in order to ensure that the filter media has equilibrated to the sample. Manufacturers' recommendations also should be consulted. Because bailers have been shown to increase

turbidity while purging and sampling, they should be avoided when sampling for trace element, metal, PCB, and pesticide constituents. If portable sampling pumps are used, the pumps should be gently lowered to the sampling depth desired, carefully avoiding being lowered to the bottom of the well. The pumps, once placed in the well, should not be moved to allow any particles mobilized by pump placement to settle. Dedicated sampling equipment installed in the well prior to the commencement of the sampling activities is one of the recommended methods to reduce turbidity artifacts (Puls and Powell, 1992; Kearl et al., 1992; Puls et al., 1992; Puls and Barcelona, 1996).

## DECONTAMINATION PROCEDURES

Once removed from the well, the purging and sampling pumps should be decontaminated by scrubbing with a brush and a non-phosphate soapy-water wash, rinsed with water, and rinsed with distilled water to help ensure that there is no cross-contamination between wells. The step-by-step procedure is:

- 1) Pull pump out of previously sampled well (or out of vehicle) and use three pressure sprayers filled with soapy water, tap water, and distilled water. Spray outside of tubing and pump until water is flowing off of tubing after each rinse. Use bristle brush to help remove visible dirt, contaminants, etc.
- 2) Have three long PVC tubes with caps or buckets filled with soapy water, tap water and distilled water. Run pump in each until approximately 2 to 3 gallons of each decon solution is pumped through tubing. Pump at low rate to increase contact time between the decon solutions and the tubing.
- 3) Try to pump decon solutions out of tubing prior to next well. If this cannot be done, compressed air may be used to purge lines. Another option is to install a check valve in the pump line (usually just above the pump head) so that the decon solutions do not run back down the well as the pump is lowered down the next well.
- 4) Prior to lowering the pump down the next well, spray the outside of the pump and tubing with distilled water. Use disposable paper towels to dry the pump and tubing.

- 5) If a hydrophobic contaminant is present (such as separate phase, high levels of PCBs, etc.), an additional decon step, or steps, may be added. For example, an organic solvent such as reagent-grade isopropanol alcohol may be added as a first rinse prior to the soapy water rinse.

If the well has been sampled with a bailer that is not disposable, the bailer should be cleaned by washing with soapy water, rinsing with tap water, and finally rinsing with distilled water. Bailers are most easily cleaned using a long-handled bottle brush.

It is especially important to clean thoroughly the portion of the equipment that will be in contact with sample water. In addition, a clean plastic sheet should be placed adjacent to or around the well to prevent surface soils from coming in contact with the purging equipment. The effects of cross-contamination also can be minimized by sampling the least contaminated well first and progressing to the more contaminated ones. The bailer cable/rope (if a bailer is used) and plastic sheet should be properly discarded, as provided in the site health and safety plan, and new materials provided for the next well.

## FIELD QUALITY CONTROL

The quality assurance (QA) targets for precision and accuracy of sampling programs are based on accuracy and precision guidelines established by the USEPA. When setting targets, keep in mind that all measurements must be made so that the results are representative of the sample water and site-specific conditions. Various types of blanks are used to check the cleanliness of the field-handling methods. These are known as field blanks, and include field equipment blanks and transport blanks. Other QA samples include spike samples and duplicates.

There are five primary areas of concern for QA in the collection of representative ground-water samples:

1. Obtaining a sample that is representative of water in the aquifer or targeted zone of the aquifer. Verify log documentation that the well was purged of the required volume or that the temperature, pH, ORP, SEC, DO and turbidity stabilized before samples were extracted.



2. Ensuring that the purging and sampling devices are made of materials and utilized in a manner that will not interact with or alter the analyses.
3. Generating results that are reproducible. Therefore, the sampling scheme should incorporate co-located samples (duplicates).
4. Preventing cross-contamination. Sampling should proceed from least to most contaminated wells, if known. Field equipment blanks should be incorporated for all sampling and purging equipment; decontamination of the equipment is therefore required.
5. Ensuring that samples are properly preserved, packaged, and shipped.

#### FIELD EQUIPMENT BLANKS

To ensure QA and quality control, a field equipment blank must be included in each sampling run, or for every twenty samples taken with the sampling device. Equipment blanks allow for a cross check and, in some cases, quantitative correction for imprecision that could arise due to handling, preservation, or improper cleaning procedures.

Equipment blanks should be taken for each sample bottle type that is filled. Distilled water is run through the sampling equipment and placed in a sample bottle (the blank), and the contents are analyzed in the lab like any other sample. Following the collection of each set of twenty samples, a field equipment blank will be obtained. It is generally desirable to collect this field equipment blank after sampling a relatively highly contaminated well. These blanks may be obtained through the following procedure:

- a) Following the sampling event, decontaminate all sampling equipment according to the site decontamination procedures and before collecting the blank.
- b) VOA field blanks should be collected first, prior to water collected for other TAL/TCL analyses. A field blank must be taken for all analyses.
- c) Be sure that there is enough distilled water in the pump so that the field equipment blank can be collected for each analysis.
- d) The water used for the field equipment blank should be from a reliable source, documented

in the field notebooks, and analyzed as a separate water-quality sample.

#### TRIP BLANKS

A trip blank should be included in each sample shipment and, at a minimum, one per 20 samples. Bottles, identical to those used in the field, are filled with reagent-grade water. The source of the reagent-grade water should be documented in the field notebooks, including lot number and manufacture. This sample is labeled and stored as though it is a sample. The sample is shipped back to the laboratory with the other samples and analysis is carried out for all the same constituents.

#### DUPLICATE SAMPLES

Duplicate samples are collected by taking separate samples as close to each other in time and space as practical, and should be taken for every 20 samples collected. Duplicate samples are used to develop criteria for acceptable variations in the physical and chemical composition of samples that could result from the sampling procedure. Duplicate results are utilized by the QA officer and the project manager to give an indication of the precision of the sampling and analytical methods.

#### HEALTH AND SAFETY CONSIDERATIONS

Depending on the site-specific contaminants, various protective programs must be implemented prior to sampling the first well. The site health and safety plan should be reviewed with specific emphasis placed on the protection program planned for the sampling tasks. Standard safe operating practices should be followed, such as minimizing contact with potential contaminants in both the liquid and vapor phases through the use of appropriate personal protective equipment.

Depending on the type of contaminant expected or determined in previous sampling efforts, the following safe work practices will be employed:

##### Particulate or metals contaminants

1. Avoid skin contact with, and accidental ingestion of, purge water.
2. Wear protective gloves and splash protection.

#### Volatile organic contaminants

1. Avoid breathing constituents venting from well.
2. Pre-survey the well head space with an appropriate device as specified in the Site Health and Safety Plan.
3. If air monitoring results indicate elevated organic constituents, sampling activities may be conducted in Level C protection. At a minimum, skin protection will be afforded by disposable protective clothing, such as Tyvek®.

General practices should include avoiding skin contact with water from preserved sample bottles, as this water will have pH less than 2 or greater than 10. Also, when filling, pre-preserved VOA bottles, hydrochloric acid fumes may be released and should not be inhaled.

#### POST-SAMPLING ACTIVITIES

Several activities need to be completed and documented once ground-water sampling has been completed. These activities include, but are not limited to:

- Ensuring that all field equipment has been decontaminated and returned to proper storage location. Once the individual field equipment has been decontaminated, tag it with date of cleaning, site name, and name of individual responsible.
- Processing all sample paperwork, including copies provided to Central Regional Laboratory, Sample Management Office, or other appropriate sample handling and tracking facility.
- Compiling all field data for site records.
- Verifying all analytical data processed by the analytical laboratory against field sheets to ensure all data has been returned to sampler.

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**GROUND-WATER SAMPLING RECORD**

Well ID: \_\_\_\_\_

Facility Name: \_\_\_\_\_

Date: \_\_\_\_/\_\_\_\_/\_\_\_\_

Station #: \_\_\_\_\_

Well Depth: \_\_\_\_\_ Depth to Water: \_\_\_\_\_ Well Diameter: \_\_\_\_\_

Casing Material.: \_\_\_\_\_ Volume Of Water per Well Volume: \_\_\_\_\_

Sampling Crew: \_\_\_\_\_

Type of Pump: \_\_\_\_\_ Tubing Material: \_\_\_\_\_ Pump set at \_\_\_\_\_ ft.

Weather Conditions: \_\_\_\_\_ NOTES: \_\_\_\_\_

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**GROUND-WATER SAMPLING PARAMETERS**

Time	Water Level	Volume Pumped	Pumping Rate	DO (mg/l)	Temp. (°C)	SEC (µS/cm)	pH	ORP (mV)	Turbidity (NTU)
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____	_____	_____

Other Parameters: \_\_\_\_\_

Sampled at: \_\_\_\_\_ Parameters taken with: \_\_\_\_\_

Sample delivered to \_\_\_\_\_ by \_\_\_\_\_ at \_\_\_\_\_

Sample CRL #: \_\_\_\_\_ OTR #: \_\_\_\_\_ ITR #: \_\_\_\_\_ SAS #: \_\_\_\_\_

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Parameters Collected

Number of Bottles

Bottle Lot Number

_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

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# Groundwater Sample Filtration Procedures

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## Purpose

The purpose of this FOP is to provide technical guidance for filtering suspended solids in groundwater samples which will be analyzed for metals.

## Scope

The purpose of sample filtration is to remove large-diameter particles which are not part of the groundwater, but attributable to the suspended solids. The actual filtering method to be employed will be determined in the field based on the quantity of suspended solids contained in the groundwater.

## Equipment and Materials

- Peristaltic pump and power supply
- In-line filters (0.45-micron)
- Tygon® Tubing
- Sample bottles and preservatives
- Shipping containers (coolers)
- Sample tags, labels, chain-of-custody forms

## Procedures and Guidelines

1. Prepare for groundwater sampling using the low-flow well purging procedure in FOP-11.
2. Connect the 0.45-micron filter cartridge directly to the discharge tubing of a peristaltic, bladder, or submersible pump.
3. Collect sample from outlet connection.
4. Dispose of in-line cartridge.
5. Following filtration, the sample will be collected in a prepreserved sample bottle.

## Attachments

None.

## Key Checks and Items

None.

# **In Situ Hydraulic Testing**

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## **Purpose**

The purpose of this FOP is to provide a general guidance for conducting pumping tests.

## **Scope**

The method described herein is applicable for conducting pumping tests in unconsolidated aquifer materials. Additional information is found in the FSP.

## **Equipment and Materials**

See below.

## **Procedures and Guidelines**

Follow the procedures as outlined in ASTM Standard D 4050-96, where appropriate.

## **Attachments**

None.

## **References**

ASTM D 4050-96.

## **Key Checks and Items**

None.

# **Sample Handling, Packaging, and Shipping**

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## **Purpose**

The purpose of this FOP is to delineate protocols for the packing and shipping of samples to the laboratory for analysis.

## **Scope**

This FOP is applicable to samples collected and prepared for analysis at an offsite laboratory.

## **Equipment and Materials**

- Waterproof hard plastic coolers
- Plastic zip lock bags
- Plastic garbage bags
- Absorbent packing material (not vermiculite)
- Inert cushioning material (not vermiculite)
- Ice
- USEPA Region 5 sample tags
- Chain-of-custody forms (generated by Forms II Lite software)
- USEPA Region 5 custody seals
- Airbills and shipping pouches (e.g., FedEx)
- Clear tape
- Strapping tape
- Mailing labels

## **Procedures and Guidelines**

### **Prepare Bottles for Shipment**

1. Arrange decontaminated sample containers in groups by sample number.
2. Check that sample container lids are tight.
3. Secure appropriate USEPA Region 5 sample tags around of container lid with string or wire.
4. Arrange containers in front of assigned coolers.
5. Affix appropriate adhesive labels to each container. Protect label with clear tape.
6. Enclose each sample in a clear, resealable, Ziploc® bag, ensuring that sample label is visible.

### **Prepare Coolers for Shipment**

1. Tape drains shut, inside and out.



2. Affix "This Side UP" labels on all four sides and "Fragile" labels on at least two sides of each cooler.
3. Place mailing label with laboratory address on top of the coolers.
4. Place inert cushioning material (e.g., bubble wrap, preformed poly-foam liner) in the bottom of the cooler. Do not use vermiculite.
5. Place chain-of-custody records with corresponding custody seals on top of each cooler.
6. Place all the samples inside a garbage bag and tie the bag.
1. Double bag and seal loose ice in resealable, plastic, zip lock bags to prevent melting ice from leaking and soaking the packing material. Place the ice outside the garbage bags containing the samples. Place sufficient ice in cooler to maintain the internal temperature at  $4 \pm 2^{\circ}\text{C}$  during transport.
8. Fill cooler with enough absorbent material (e.g., Perlite, kitty litter, etc.) and packing material to prevent breakage of the sample bottles and to absorb the entire volume of the liquid being shipped (offsite sample shipment only).
9. Sign each chain-of-custody form (or obtain signature) and indicate the time and date the cooler was custody sealed. Record the USEPA Region 5 custody seals on the chain-of-custody forms.
10. Seal the laboratory copies of the chain-of-custody forms in a large resealable plastic zip lock bag and tape to the inside lid of the cooler. Retain the Region copies of the chain-of-custody forms for return to USEPA. Each cooler must contain a chain-of-custody form (or forms) that corresponds to the contents of the cooler.
11. Close lid and latch.
12. Carefully peel custody seals from backings and place intact over lid openings (right front and left back). Cover seals with clear protection tape.
13. Tape cooler shut on both ends, making several complete revolutions with strapping tape. Do not cover custody seals.
14. Relinquish to carrier (e.g., FedEx). Place airbill receipt inside the mailing envelope and send to sample documentation coordinator, along with the other documentation.

### **High Concentration Samples or NAPL Samples**

When shipping high concentration or NAPL samples, consult the CH2M HILL dangerous goods shipping handbook. Contact CH2M HILL's dangerous goods shipping coordinator, Rob Strehlow, at the Milwaukee equipment warehouse (414-257-4615) for assistance.

### **Attachments**

None.

### **Key Checks and Items**

None.

# Field Logbook

---

## Purpose

The purpose of this FOP is to delineate protocols for recording field survey and sampling information in a field logbook.

## Scope

Data generated from the use of this FOP may be used to support the following activities: site characterization, risk assessment, and evaluation of remedial alternatives.

## Equipment and Materials

- Field logbook
- Indelible black ink pen

## Procedures and Guidelines

All information pertinent to a field survey or sampling effort will be recorded in a bound field logbook that will be initiated at the start of the first onsite activity. The field logbook will consist of a bound notebook with consecutively numbered pages that cannot be removed. The outside front cover of the logbook will contain the project (site) name and the specific activity (e.g., remedial investigation sampling). The inside front cover will include:

- Site name and USEPA work assignment number
- Project number
- Site manager's name and mailing address
- Sequential logbook number
- Start date and end date of logbook

Each page will be consecutively numbered, dated, and initialed. All entries will be made in indelible black ink, and all corrections will consist of line-out deletions that are initialed and dated. If only part of a page is used, the remainder should have an "X" drawn across it. At a minimum, entries in the logbook will include the following:

- Time of arrival and departure of site personnel, site visitors, and equipment
- Instrument calibration information, including make, model, and serial number of the equipment calibrated
- Field observations (e.g., sample description, weather, unusual site conditions or observations, sources of potential contamination, etc.)
- Detailed description of the sampling location, including a sketch

- Details of the sample site (e.g., the elevation of the casing, casing diameter and depth, integrity of the casing, etc.)
- Sampling methodology and matrix, including distinction between grab and composite samples
- Names of samplers and crew members
- Start or completion of borehole and monitoring well installation; sample collection activities
- Field measurements (e.g., photoionization detector readings, pH, water levels)
- Type of sample (e.g., groundwater, soil)
- Number, depth, and volume of sample collected
- Field sample number
- Requested analytical determinations
- Sample preservation
- Quality control samples
- Sample shipment information including chain-of-custody form number, carrier, date, and time
- Health and safety issues (including level of personal protective equipment)
- Signature and date by personnel responsible for observations

Sampling situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. Records should, however, contain sufficient information so that someone can reconstruct the sampling activity without relying on the collector's memory. The field team leader will keep a master list of all field logbooks assigned to the sampling crew.

## **Attachments**

None.

## **Key Checks and Items**

None.

# Documentation / Chain-of-Custody Procedure

---

## Purpose

The purpose of this FOP is to provide a definition of “custody” and describe protocols for documenting the transfer of custody from one party to the next (e.g., from the site to the laboratory). A documented custody trail is established through the use of sample tags and a USEPA chain-of-custody form which uniquely identifies each sample container, and who has possession of it from the sample’s origin to its final destination. The chain-of-custody form also describes the sampling point, date, time, and analysis parameters.

## Scope

Sample personnel should be aware that a sample is considered to be in a person’s custody if the sample meets the following conditions:

- It is in a person’s actual possession
- It is in view after being in a person’s possession
- It is locked up so that no one can tamper with it after having been in physical custody

When samples leave the custody of the sampler, the cooler must be custody-sealed and possession must be documented.

Data generated from the use of this FOP may be used to support the following activities: site characterization, risk assessment, and evaluation of remedial alternatives.

## Equipment and Materials

- Computer with Forms II Lite software loaded
- Printer with paper (8.5- × 11-inch) and ink cartridge (black or color)
- USEPA Region 5 Sample Tag
- Forms II Lite generated tag label (encouraged, but not mandatory)
- Indelible black ink pen

## Procedures and Guidelines

### Chain-of-Custody Forms

The chain of custody form must contain the following information:

- CASE NUMBER/CLIENT NUMBER: If a CLP laboratory is used, enter the case number provided by EPA’s RSCC. If the CLP is not used, enter the SAS number provided by CH2M HILL’s Sample and Analytical Coordinator.

- USEPA REGION: Enter Region "5."
- CERCLIS ID: For OMC, use "ILD000802827."
- SPILL ID: For OMC, use "0528."
- SITE NAME/STATE: For OMC, this will be "OMC PLANT 2", "IL."
- PROJECT LEADER: Enter the CH2M HILL site manager.
- ACTION: For OMC, choose "Remedial Investigation."
- SAMPLING CO.: "CH2M HILL."
- SAMPLE NO.: This is the unique number that will be used for sample tracking. For CLP, this number is taken from a block of numbers assigned by the EPA RSCC. For non-CLP, the CH2M HILL Sample and Analytical Coordinator will assign this number.
- MATRIX: Describes the sample media (e.g. groundwater, soil, wipe, etc.).
- SAMPLER NAME: The name of the sampler or sample team leader.
- CONCENTRATION: Low (L), Low/Medium (M) or High (H).
- SAMPLE TYPE: "Grab" or "Composite."
- ANALYSIS: This indicates the analyses required for each sample.
- TAG NO.: This number appears on the bottom of the sample tag and includes a prefix ("5") followed by a series of numbers. The entire number must appear on the chain-of-custody form.
- PRESERVATIVE: Document what preservative has been added to the sample (e.g. "HCl," "ice only," "none").
- STATION LOCATION: This is the CH2M HILL Station Location Identifier.
- SAMPLE COLLECT DATE/TIME: Use military time.
- QC TYPE: This is for field QC only, and includes field duplicate, field blanks, equipment blanks, and trip blanks.
- DATE SHIPPED: The date that samples are relinquished to the shipping carrier.
- CARRIER NAME: (e.g., "FedEx").
- AIRBILL: Airbill number used for shipping. (If samples are hand delivered to their destination, "hand delivered" should appear in this field.)
- SHIPPED TO: This is the laboratory name and full address, including the laboratory contact. If the contact is not known, use "Sample Custodian."
- CHAIN OF CUSTODY RECORD fields: This sampler's signature must appear in the "Sampler Signature" and the "Relinquished By" fields. The date and time (military time) must also be included. If additional personnel were involved in sampling, their signatures should appear in the "Additional Sampler Signature(s)" field.

Although the samples are “relinquished” to the shipping carrier, the shipping carrier does not have access to the samples as long as the shipping cooler is custody sealed. Consequently, the shipping carrier does not sign the chain-of-custody form.

- **SAMPLE(S) TO BE USED FOR LABORATORY QC:** This identifies which samples are to be used for matrix spike/matrix spike duplicate analyses.
- Indicate if shipment for case is complete: Use “Y” or “N.”
- **CHAIN-OF-CUSTODY SEAL NUMBER:** Record the custody seal numbers that appear on the Region 5 custody seals that can be found on the shipping container. There is usually a minimum of two per shipping container.

## Sample Tags

Each sample container will be identified with a uniquely numbered sample tag issued by USEPA Region 5. Each tag will contain the following information:

- Case/SAS number
- The unique sample number for sample tracking
- CH2M HILL station location (i.e., the sample identifier)
- Date of sampling
- Time the sample was collected (in military time)
- All parameters for which the sample will be analyzed
- Preservative used (if any)
- Sample type (grab or composite)
- Sample concentration (low, medium, high)
- Sample matrix (groundwater, soil, air, etc.)
- The signature of sample team leader
- Identification when sample is intended to be used by the lab for matrix spike/spike duplicate

## Attachments

- Attachment 1: Forms II Lite Quick Reference Guide
- Attachment 2: Chain-of-Custody Form, Sample Tag, Custody Seal

## Key Checks and Items

- All sample containers must be properly tagged.
- Each cooler must have a chain-of-custody form and the samples in the cooler (as identified by the sample tags) must match what is on the chain-of-custody form.
- Each chain-of-custody form must be properly relinquished (signature, date, time).
- The custody seal numbers must be written on each chain-of-custody form.
- The shipping cooler must be custody sealed in at least two places.

# FOP-16, Attachment 1

## Forms II Lite Quick Reference Guide

### Getting Started

- a) Click on the **Start** button on the Windows Desktop and select **Programs**. Select **Forms II Lite** and click on the **FORMS II Lite** item. The FORMS II Lite application will begin.
- b) Click **File** on the Main Menu bar. Click on the **New Site** item. The first data entry screen will appear.

### Step 1 - Enter Site Information

- a) Enter all relevant information necessary for Chain-of-Custody paperwork (in accordance with Regional guidance). For CLP Traffic Reports (TRs) this includes:
  - Site Name
  - State
  - EPA Region Number
  - CLP Case Number
  - Lead Sampler
- b) Click the **Next** button to proceed to Step 2.

### Step 2 - Select Sampling Team

- a) Select sampling team members from the **Unassigned Team Members** window by clicking on each name.
- b) Click the **>** button. The selected name will move to the **SelectedTeam** window. Repeat until all team members for this sampling event are selected.
- c) Click the **Add/Edit Team Members** button to add any remaining sampling team members names that do not appear in the **Unassigned Team Members** window.
- d) Enter the first and last name of each sampler. If you would like to add the sampler to the permanent list, click the **Add to Permanent List** box. After you have entered the samplers' names, click the **OK** button. These samplers will appear in the **Selected Team Members** window on the Select Sampling Team screen.
- e) Click the **Next** button to proceed to Step 3.

### Step 3 - Select Analysis

- a) Select an analysis from the **Available Analyses** window by clicking on the analysis.
- b) Click the **>** button. The selected analysis will move to the **Selected Analyses** window. Repeat until all analyses to be performed on samples collected for this sampling event are selected.
- c) To edit Turnaround Time, click the **Edit Turnaround Days** button. The **Edit Project and Turnaround** screen will appear.
- d) Click on the **Turnaround Time** drop down menu to select the number of days or type in a value. Click **Close** to close screen.
- e) Click the **Next** button to proceed to Step 4.

## Step 4 - Enter Station

- a) Enter all relevant information necessary for Chain-of-Custody paperwork (in accordance with Regional guidance). For CLP TRs this includes:
  - Station Name and Location
  - Sample Matrix
  - Sample Date/Time
  - Sample Type
  - Sampler Name
- b) The Sample Date/Time field is strictly military time. You may click on the System Date/Time checkbox to populate the current system date/time value into the sample date/time.
- c) Click the **Add Station** button to enter the name of a new station and continue with the station locations. To enter a new station location associated with a previously entered station, click on the station name, then click the **Add Location** button, and enter the name of the new station location.
- d) Click the **Next** button to proceed to Step 5.

## Step 5 - Assign Bottles and Samples

- a) Select the Station Location from the **Station/Location** window.
- b) Select the analyses associated with the containers from the **Analysis** window. If more than one analysis is associated with a container, select the additional analysis(es) by holding down the control key, and clicking on the additional analysis(es).
- c) Enter the number of bottles that will be assigned a specific analysis or set of analyses.
- d) Enter the sample tag prefix and starting tag number. Click **Auto Increment Tag Number** if you wish to assign sequential tag numbers for your sampling event. Sample numbers are automatically and sequentially assigned for your sampling event and are unique per Station Location.
- e) By default CLP sample numbers are automatically used for CLP analyses. Note that FORMS II Lite generates CLP sample numbers using a BASE 32 system which differs from the CLASS generated CLP sample numbers.
- f) Edit the sample number and other pertinent information for these samples in the space provided. After you have confirmed your entries, click the down arrow.
- g) Repeat steps 5b through 5f until all desired analyses have been assigned to bottles.
- h) Click the **Next** button to proceed to Step 6.

## Generate Labels

- a) Click the **Generate Labels** button in Step 5. The application automatically displays samples for the current Station Location. These are the samples for which labels will be generated. Click the appropriate checkbox at the bottom of the screen to select all samples for the station or site. Enter the number of labels to print next to each record if you need more than one.
- b) Click the **Generate Labels** button and select the appropriate label template to view, then click **OK**. Edit an existing template by clicking the **Edit Label** button. If you wish to add a new label template, click the **Add New Label** button and follow the wizard to create a



new template. Enter the number of blank labels to control printing on a label other than the first one on the page.

- c) View the labels at the end of the edit label or new label process. If labels are not acceptable, close the view and edit the label template. If the labels are acceptable, print the labels.
- d) Select **File** and then **Print** from the Main Menu bar. Select the desired number of copies to be printed and click the **OK** button to print the labels. Click **Close** to return to Step 5.

### Step 6 - Select Samples and Assign Lab

- a) Select a laboratory from the **Lab Code** drop down menu. If the laboratory where samples will be shipped does not appear in the list, click the **Add Lab** button and add the lab information.
- b) Select samples from the **Unassigned Samples** window by holding down the [Ctrl] key and clicking on each sample that will be shipped to this laboratory. After you have selected all the samples for the laboratory, click the down arrow.
- c) Repeat steps 6a and 6b until all samples have been assigned to laboratories.
- d) Click the **Next** button to proceed to Step 7.

### Step 7 - Select Labs and Assign Shipping

- a) Enter the carrier, date of shipment and airbill number.
- b) Select samples from the **Unassigned** window by holding down the [Ctrl] key and clicking on each sample that will be shipped using this airbill. After you have selected the samples to be shipped, click the down arrow.
- c) Repeat steps 7a and 7b until all samples have been assigned airbill numbers.
- d) Click the **Finish** button for system generated TRs. FORMS II Lite will then display a screen that enables you to view and print TRs for the site.
- e) Click **Next** and proceed to Step 8 to customize TRs for specific sets of samples.

### Step 8 - Customize Traffic Report

- a) Confirm the last four digits of the TR number. (The first two digits represent the Region number, the next nine digits are a random number and the next six digits are the date the TR was created, and the last four digits are automatically incremented by the system but may be edited by the user.)
- b) Select a shipment from the **Shipping** window. Select the samples from the **Samples** window that will be assigned to this TR. After you have selected the samples, click the down arrow. (NOTE: samples must be of the same program type and must have the same project code to be assigned to a single TR.)
- c) Repeat steps 8a and 8b until all samples have been assigned.
- d) Click the **Finish** button. FORMS II Lite will display a screen that will enable you to view, print, archive and export TRs. Follow the directions to print the TRs.

### Quick Edit

- a) On the **View/Print TR** screen displayed after completion of Step 8, click the **Quick Edit** button.

- b) The user may edit most data fields, except those in red, prior to printing a TR. Also able to sort and filter any column and print a report.

### Helpful Hints to Use FORMS II Lite 4.0

This Quick Reference Guide is designed to help FORMS II Lite users enter information for their sampling events and generate bottle labels and Chain-of-Custody paperwork. FORMS II Lite provides users the flexibility to enter most of their information ahead of the sampling event.

#### FORMS II Lite allows users to:

- Add values that are not included in the "list and pick" menus: Select **Admin** from the Main Menu bar, enter the password to log in. **Admin** now shows the user as being **(logged in)**. Select **Reference Tables**, and choose the table that requires editing.
- Customize screens and disable non-key fields: While logged into **Admin** on the Main Menu Bar, select **Custom Features** and click on **Field Names**. Field names and non-key fields can be renamed or hidden on the screen.
- Review the data entered throughout the data entry process by clicking on the **Quick View** button in Steps 4 through 8.
- Select multiple items by highlighting the first item, then hold down the [Ctrl] key and click on the additional items. Or simply click and drag to highlight multiple items.
- Sort data displayed in windows by clicking on the column label. Click on a second column label for a secondary sort.
- Specify more than one sampler's name for samples collected at a
- specific station location. In Step 4, select a sampler's name, then click within the data entry field after the name. Type a comma and type in the second name.
- Export Site information as either a text or (.dbf) file.
- **Note:** FORMS II Lite will not allow information that has been typed over to be saved as a separate file. Once a value in a field has been replaced (edited) with a new value, the original value is lost.

#### User Preferences

- The following features are maintained in **User Preferences** under **Admin** on the Main Menu bar and can be turned on or off.
- Select **Copy Station** to make the button available in Step 4 to duplicate the current station and its station location information. **Copy Location** duplicates station locations.
- Select the option **Use Default Number of Bottles**, set in the Analysis Reference Tables, to populate the number of containers for each analysis in Step 5.

- Select **Assign All** to make the button available in Step 5 to assign each of the analyses to a separate container. Set the number of containers for each analysis in the bottles field or define through User Preferences.
- Select **One-Step Printing** to make this button available in Step 5 to print labels or tags with a single click. Label template, and number of copies are defined in User Preferences.

# FOP-16, Attachment 2

## Chain-of-Custody Form, Sample Tag, Custody Seal

<b>USEPA Contract Laboratory Program</b> Generic Chain of Custody				Reference Case: <span style="font-size: 1.5em; float: right;">R</span> Client No: 04CK01																					
Project: 5 Project Code: TGS 10R Account Order: 6L0000802827 CENCLIS ID: 0528 Site Name/State: OMC Plant SWL Project Leader: Jane Stumacher Action: Remedial Investigation Sampling Co: CH2M HILL		Date Shipped: 08/30/2004 Carrier Name: FedEx Airbill: 1234567890 Shipped to: Any Lab 1234 West 5th Street Suite 66 Whitefish MN 55989 (800) 111-2345		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2">Chain of Custody Record</th> </tr> <tr> <td>Relinquished By</td> <td>(Date / Time)</td> </tr> <tr> <td colspan="2">1. Joe Sample 8/30/04 18:45</td> </tr> <tr> <td>2</td> <td></td> </tr> <tr> <td>3</td> <td></td> </tr> <tr> <td>4</td> <td></td> </tr> </table>		Chain of Custody Record		Relinquished By	(Date / Time)	1. Joe Sample 8/30/04 18:45		2		3		4									
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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th>SAMPLE No.</th> <th>WTR/SAMPLER</th> <th>CONC/TYPE</th> <th>ANALYST/TURNAROUND</th> <th>TAGS/PRES SHAWTS/Bottle</th> <th>STATION LOCATION</th> <th>SAMPLE COLLECT DATE/TIME</th> <th>CC Type</th> </tr> <tr> <td>04CK01-12</td> <td>Ground Water/ JOE SAMPLER</td> <td>L/G</td> <td>STEX (21)</td> <td>512362 (HCL), 512363 (HCL), 512364 (HCL) (3)</td> <td>OMC-MW01S-01</td> <td>8: 08/30/2004 13:30</td> <td></td> </tr> </table>		SAMPLE No.	WTR/SAMPLER	CONC/TYPE	ANALYST/TURNAROUND	TAGS/PRES SHAWTS/Bottle	STATION LOCATION	SAMPLE COLLECT DATE/TIME	CC Type	04CK01-12	Ground Water/ JOE SAMPLER	L/G	STEX (21)	512362 (HCL), 512363 (HCL), 512364 (HCL) (3)	OMC-MW01S-01	8: 08/30/2004 13:30		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2">DESIGNATE</th> </tr> <tr> <td>Comp.</td> <td>Grab</td> </tr> <tr> <td colspan="2">         Sample Number: 04CK01-12          Station Location: OMC-MW01S-01          ANALYSIS: CLP TCL Volatiles          Sample Date/Time: 08/30/2004/ 13:30          Matrix: Ground Water          Preservative: HCL          Sampler(s): JOE SAMPLER          Tag Number: 512345       </td> </tr> </table>		DESIGNATE		Comp.	Grab	Sample Number: 04CK01-12 Station Location: OMC-MW01S-01 ANALYSIS: CLP TCL Volatiles Sample Date/Time: 08/30/2004/ 13:30 Matrix: Ground Water Preservative: HCL Sampler(s): JOE SAMPLER Tag Number: 512345	
SAMPLE No.	WTR/SAMPLER	CONC/TYPE	ANALYST/TURNAROUND	TAGS/PRES SHAWTS/Bottle	STATION LOCATION	SAMPLE COLLECT DATE/TIME	CC Type																		
04CK01-12	Ground Water/ JOE SAMPLER	L/G	STEX (21)	512362 (HCL), 512363 (HCL), 512364 (HCL) (3)	OMC-MW01S-01	8: 08/30/2004 13:30																			
DESIGNATE																									
Comp.	Grab																								
Sample Number: 04CK01-12 Station Location: OMC-MW01S-01 ANALYSIS: CLP TCL Volatiles Sample Date/Time: 08/30/2004/ 13:30 Matrix: Ground Water Preservative: HCL Sampler(s): JOE SAMPLER Tag Number: 512345																									

Shipment for Case Complete? <input type="checkbox"/>		Sample(s) to be used for Laboratory QC:	
Analyte Key:	Concentration:	L - Low, M - Medium, H - High	
STEX = (Benzene, Toluene, Ethylbenzene, Xylenes)			
<b>TR Number: 5-484657676-051304-0004</b> <small>TR provides preliminary results. Request for preliminary results will become final.</small> <small>Send Copy to: Sample Management Office, 1000 Edmund Hayes Dr., Reston, VA 20191-4400</small>			

U.S. ENVIRONMENTAL PROTECTION AGENCY  
OFFICE OF PUBLIC AFFAIRS  
NO. 136607

Sample Number: 04CK01-12  
Station Location: OMC-MW01S-01  
ANALYSIS: CLP TCL Volatiles  
Sample Date/Time: 08/30/2004/ 13:30  
Matrix: Ground Water  
Preservative: HCL  
Sampler(s): JOE SAMPLER  
Tag Number: 512345

-0606, 136607

REGION COPY

# Decontamination of Drilling Rigs and Equipment

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## Purpose and Scope

The purpose of this guideline is to provide methods for the decontamination of drilling rigs, downhole drilling tools, and water-level measurement equipment. Personnel decontamination procedures are not addressed in this FOP. For a detailed list of personnel decontamination procedures, please refer to the HSP and FOP-18, *Decontamination of Personnel and Equipment*. Sample bottles will not be field-decontaminated; instead, they will be purchased with certification of laboratory sterilization.

## Equipment and Materials

- Portable steam cleaner and related equipment
- Potable water
- Phosphate-free detergent such as Alconox® or Liquinox®
- Buckets
- Brushes
- Distilled water
- 10 percent isopropyl alcohol solution
- Methanol
- ASTM-Type II Reagent-Grade Water
- Aluminum foil

## Procedures and Guidelines

### Drilling Rigs and Monitoring Well Materials

Before the onset of drilling, after each borehole, and before leaving the site, heavy equipment and machinery will be decontaminated using a phosphate-free detergent solution and high-pressure hot water at a designated area. The equipment shall then be rinsed with potable water. The steam cleaning area will be designed to contain decontamination wastes and waste waters, and can be an HDPE-lined, bermed pad. A pumping system will be used to convey decontamination water from the pad to the drums.

Surface casings may be steam-cleaned in the field if they are exposed to contamination at the site before use.

## **Downhole Drilling Tools**

Downhole tools will be decontaminated as described above (1) before the onset of drilling and (2) between boreholes. This will include rods, split spoons or similar samplers, coring equipment, auger bolts, augers, and casing.

Before the use of a sampling device such as a split-spoon sampler to collect soil samples for physical characterization or chemical analysis, the sampler shall be cleaned by scrubbing with a potable water/phosphate-free detergent solution, rinsing with potable water, and then rinsing with distilled water. If equipment has come in contact with oil or grease, rinse the equipment with methanol, and then distilled water.

## **Field Analytical Equipment**

### **Water Level Indicators**

Water level indicators consisting of a probe that comes into contact with the groundwater must be decontaminated using the following steps:

1. Rinse with tap water
2. Wash with phosphate-free detergent solution
3. Solvent rinse with 10 percent methanol solution
4. Rinse with distilled water

### **Probes**

Probes, pH or specific ion electrodes, geophysical probes, and thermometers that have come into direct contact with the sample will be decontaminated using the procedures specified above, unless manufacturer's instructions indicate otherwise. For probes that do not make direct contact (e.g., OVM equipment), the probe will be wiped with clean paper towels or a cloth wetted with a 10 percent methanol solution.

## **Attachments**

None.

## **Key Checks and Preventive Maintenance**

The effectiveness of field cleaning procedures will be monitored by rinsing decontaminated equipment with distilled water and then submitting the rinse water in standard sample containers for analysis as Equipment Blanks. Each time a sampling event occurs, at least one such quality control sample shall be collected, as specified in the QAPP. At least one piece of field equipment shall be selected for this procedure each time the equipment is washed. An attempt should be made to select different pieces of equipment for this procedure.

# **Decontamination of Personnel and Equipment**

---

## **Purpose**

The purpose of this FOP is to provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

## **Scope**

This is a general description of decontamination procedures.

## **Equipment and Materials**

- Distilled water
- 2.5 percent (w/w) Alconox<sup>®</sup>, Liquinox<sup>®</sup>, or equivalent phosphate-free detergent and water solution
- 10 percent isopropyl alcohol solution (DO NOT USE ACETONE.)
- Large plastic pails or tubs for Alconox, Liquinox, or equivalent and water, scrub brushes, squirt bottles for detergent solution, methanol and water, resealable plastic bags and sheets
- Methanol
- DOT approved, 55-gallon drum (or equivalent) for disposal of waste
- Unpowdered chemical-resistant gloves
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

## **Procedures and Guidelines**

### **Personnel Decontamination**

To be performed after the completion of tasks whenever the potential for contamination exists, and also upon leaving the exclusion zone.

1. Wash boots in detergent solution, then rinse with water. If disposable latex booties are worn over boots in the work area, remove and discard into a DOT-approved, 55-gallon drum.
2. Remove and discard outer chemical-resistant gloves into a DOT-approved, 55-gallon drum.

3. Remove disposable Tyvek® coveralls and discard into a DOT-approved, 55-gallon drum.
4. Remove respirator (if worn).
5. Remove inner gloves and discard.
6. At the end of the workday, shower entire body, including hair, either at the worksite or at home.
7. Sanitize respirator (if worn).

### **Sampling Equipment Decontamination—Groundwater Sampling Pumps**

Sampling pumps are decontaminated after each use as follows:

1. Wear unpowdered chemical-resistant gloves.
2. Spread plastic on the ground to prevent hoses from touching the ground.
3. Turn off the pump after sampling. Remove the pump from the well, and place it in a decontamination sleeve/tube, making sure that any tubing does not touch the ground.
4. Turn the pump back on, and pump 1 gallon of detergent solution through the sampling pump.
5. Rinse with 1 gallon of 10 percent isopropyl alcohol solution pumped through the pump. DO NOT USE ACETONE.
6. Rinse with 1 gallon of potable water.
7. Rinse with 1 gallon of distilled water.
8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or put in new resealable plastic bag.
9. Collect all rinsate and dispose of in a DOT-approved, 55-gallon drum or bulk storage poly tank.
10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved, 55-gallon drums.

### **Sampling Equipment Decontamination—Other Equipment**

Reusable sampling equipment is decontaminated after each use as follows:

1. Wear unpowdered chemical-resistant gloves.
2. Rinse and scrub with potable water.
3. Wash all equipment surfaces that came into contact with the potentially contaminated soil/water with detergent solution.
4. Rinse with potable water.
5. Rinse with distilled water.



6. If equipment has come in contact with oil or grease, rinse the equipment with methanol and then distilled water.
7. Completely air dry or wipe dry with a clean paper towel. Wrap exposed areas with aluminum foil (shiny side out) or enclose equipment in clean plastic for transport and handling if equipment will not be used immediately.
8. Collect all rinsate and dispose of in a DOT-approved, 55-gallon drum.
9. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved, 55-gallon drums.

### **Health and Safety Monitoring Equipment Decontamination**

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with detergent solution, then a towel wet with alcohol solution, and finally two times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved, 55-gallon drum.

### **Sample Container Decontamination**

The outside of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with detergent solution, or immerse in the solution *after the containers have been sealed*. Repeat the above steps using potable water.
2. Dispose of all used paper towels in a DOT-approved, 55-gallon drum.

### **Attachments**

None.

### **Key Checks and Items**

- Do not use acetone for decontamination.
- Drum all contaminated rinsate.
- Clean with solutions of Alconox, Liquinox, or equivalent phosphate-free detergent, isopropyl alcohol, and distilled water.

# Equipment Calibration

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## Purpose

The purpose of this FOP is to provide general guidelines for the calibration of sampling equipment and monitoring equipment used during fieldwork.

## Scope

This is a general description of calibration procedures.

## Equipment and Materials

- PID (Mini-RAE 2000, OVM or equivalent)
- CGI (MSA Watchman or equivalent)
- Multiparameter aqueous probe (Horiba U-22 Water Checker, YSI® 600-XL or equivalent)

## Procedures and Guidelines

Because instruments used during the field investigation may be several models produced by many manufacturers, it is not feasible to present instrument-specific details. Instead, instrument-specific calibration will be performed in accordance with each manufacturer's instructions in regard to both frequency and method.

## Attachments

None.

## Key Checks and Items

- Make sure the manufacturer's calibration instruction/user manual is included with the equipment.
- Make sure all materials necessary for calibration are present (e.g., correct calibration gas/calibration standards, correct regulator, correct tubing, spare batteries and charging equipment, if equipment must be run off internal batteries).

# Indoor Air Sample Collection

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## Purpose

The purpose of this FOP is to provide a guide for operators responsible for operation with SUMMA™ canisters for collection of volatile organic compounds (VOCs) in ambient air samples.

## Scope

This procedure applies to the collection of both indoor and outdoor ambient air VOC samples.

## Equipment and Materials

- Sample canisters consist of stainless steel that has been treated by the SUMMA passivation process.
- For time composite samples, a vacuum flow regulator is mounted on the canister valve. This regulator is preset at a sample rate that will provide the desired sample time.
- A particulate filter must be attached to the flow regulator to prevent clogging of the fine passages in the vacuum flow regulator.

## Procedures and Guidelines

1. Immediately before sampling, check the vacuum integrity of all canisters. There are two styles of canisters:
  - "Style A" has a gauge permanently attached to the canister and shows the vacuum of the canister continually. Simply read the already attached gauge before and after sampling.
  - "Style B" has no gauge attached to it. A separate gauge is included with the shipment for checking the canister vacuum.
2. While in a relatively clean atmosphere, remove the Swagelock end cap fitting on the top valve (use 9/16-inch wrench).
3. Attach the supplied gauge to the canister (finger tight plus 1/8 turn with 9/16-inch wrench).
4. Attach a supplied particulate filter to the inlet of the gauge.
5. Open the top valve (turn counterclockwise two turns maximum) and note the gauge reading.

6. Close valve (turn clockwise).
7. Replace Swagelock end cap fitting to the inlet of the particulate filter.
8. Vacuum should be about 30 inches Hg. If vacuum is less than 28 inches or differs from what the laboratory indicated on the data tag, careful consideration should be performed before use of the canister. Record vacuum on field sample sheet.

## Obtaining Samples

1. Initial flow rates can be determined with a mass flow meter. The initial flow rate and initial vacuum (28 to 30 inches of Hg) should be recorded on the sample data sheet. If an adjustable flow controller is provided, adjust the flow rate so that at the end of the sampling interval the ending pressure of the canister is about 25 inches of Hg.  
Note: Disregard this step if a nonadjustable (capillary tube) flow controller is provided.
2. Start sampling period by removing the Swagelock end cap fitting and opening the valve on the SUMMA canister with the flow controller/filter attached to it.
3. VOC samples are collected with SUMMA canisters by opening the flow-controlled valve and slowly filling the canister using a flow controller to collect a time-integrated sample. Samples typically are collected over an 8-hour period, although sample periods can be adjusted to suit sampling condition and limitations. Since a constant flow rate is maintained, the resulting sample will have a VOC content that is the average of the VOC concentrations for the sampling interval (a time-integrated sample).
4. When the sample period is over, close the valve (clockwise until finger tight).
5. Vacuum check canister again to confirm that the equipment functioned properly. The gauge used to check the initial vacuum should be the same used to check the final pressure of any canister, this will avoid cross contamination.
  - Final pressures should be between 2 and 5 inches of Hg vacuum or as close to this vacuum as possible. Higher vacuums will still produce a valid sample, however detection limits may be elevated.
  - There will likely be some variation in final vacuum reading between cans. This is due to flow rates that change slightly due to rough handling during shipment and changes in temperature. (This is most noticeable in mid-summer and mid-winter.) This will not affect analytical results in any way. The accuracy of the regulators decrease slightly while sampling between 5 and 10 inches of Hg vacuum but should still be within  $\pm 10$  percent.
6. Record final vacuum readings on the sample sheet and on tags.
7. Replace Swagelock end cap fitting and return canister for analysis.

**Caution:** Do not attach adhesive labels directly to canisters. Use the tags provided or attach labels to the tags provided.

## **Sample Preparation for Transport**

- Each collected SUMMA canister (whether for soil gas or ambient air) will be appropriately labeled, packaged along with the appropriate chain-of-custody forms, and sent to the analytical laboratory with overnight delivery.
- If possible, this will be done on the same day as sample pickup, or on the following day at the latest. No special preservatives are required.
- Custody seals will be placed on each package before shipping.
- The technical sample holding time is 14 days, and no special preservation methods or temperature are required.

## **Attachments**

None.

## **References**

None.

## **Key Checks and Items**

- The laboratory supplying the canisters tracks the integrity of whole air samples in SUMMA passivated canisters by using a canister chain-of-custody form. This form allows the tracking of canister vacuum and pressure readings from the laboratory to the client and back to the laboratory.
- Before shipment of canister to the field, the canister vacuum is checked and recorded on the chain-of-custody form or on the sample tag affixed to the canister. Once received in the field, the sampler checks the vacuum of the canister and records it on a log sheet. After sampling, read the vacuum again and record prior to shipment back to the laboratory. Upon receipt at the laboratory, sample receiving personnel will check and record the canister vacuum or pressure reading.
- Once the canister chain-of-custody form is completed, it contains the information needed to assure that the canister did not leak during shipment, prior to and after sampling, and during shipment back to the laboratory. In this way, the data user can determine whether the sample integrity had been maintained by reviewing the canister chain-of-custody form.
- Cap the SUMMA canister.

# Soil Gas Sample Collection Using Summa™ Canisters

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## Purpose

The purpose of this FOP is to provide a general guideline for the collection of soil gas samples using Summa canister sampling methods.

## Scope

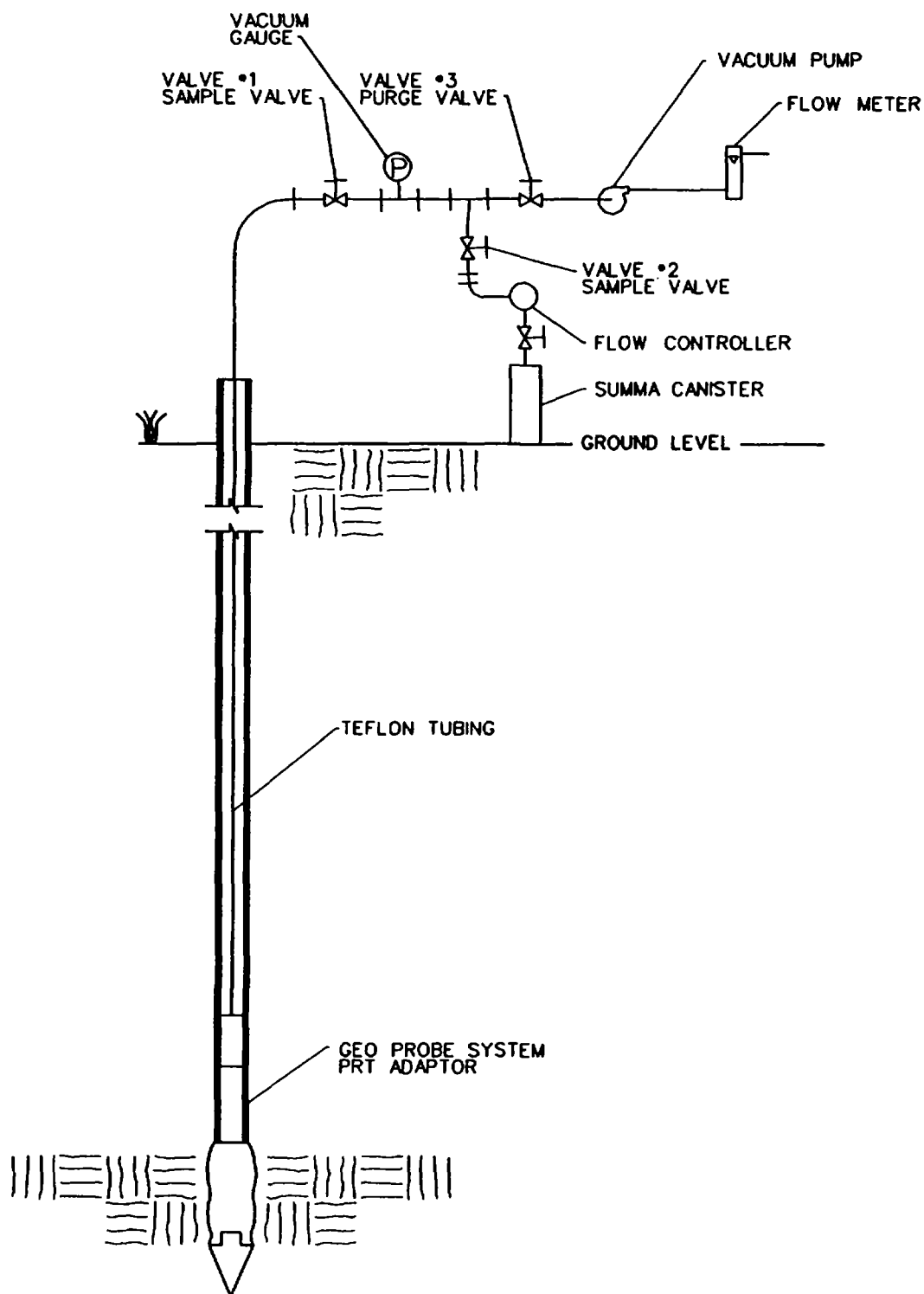
The method described for collection of soil vapor samples from Geoprobe® systems (or equivalent) soil gas probes (with PRT adapters) into Summa canisters. Specific equipment and responsibilities of direct push subcontractors are described in contracting documentation.

## Equipment and Materials

### System Setup

1. Acquire all the necessary hardware and sampling equipment shown in Figure 1.
2. Assemble or obtain the necessary fittings and vacuum gauge to create a soil gas probe and sampling interface (Figure 1). The interface must be clean, free of oils, and flushed free of VOCs before use. Note: Use only gas-tight fittings such as Swagelok or equivalent.
3. Adjust the purge system evacuation pump sampling rate to achieve the desired flow rate of between 100 to 200 milliliters /min. This should be performed at the outlet of the vacuum pump before purging, either by use of a suitable flowmeter or determining the amount of time required to fill a 1-liter Tedlar® bag.
4. Summa canisters are preevacuated by the laboratory. In some cases (e.g., project-specific QA), the vacuum must be verified in the field before use. This is accomplished with a vacuum gauge and instructions supplied by the laboratory.
5. Flow controllers (if used) should come preset by the laboratory to sample at a rate of 100 to 200 cc/min. Verify the flow controller flow rate setting (indicated on the tag). In some cases the flow rate must be verified in the field before use. This is accomplished with a bubble meter, vacuum source, and instructions supplied by the laboratory.

**FIGURE 1**  
Soil Gas/Evacuated Sampler Sampling System



## System Leak Checking and Purging

Make sure the sampling system is assembled by connecting the sampling interface to the soil gas probe, the Summa canister, and the purge system (Figure 1).

- **Leak Check:** Perform a leak check of the sample interface system by:
  - Making sure the gas probe valve (valve #1) is closed.
  - Making sure the sample valve (valve #2) leading to the Summa canister is closed.

*Caution:* Never open the valve a fixed to the canister during purging. Doing so results in loss of vacuum and sample integrity.

  - Open the purge valve (valve #3).
  - Operate the purge pump to achieve a vacuum gauge reading of 10 inches of Hg or to a vacuum that will be encountered during sampling, whichever is greater.
  - A leakfree system will be evident by closing off the purge valve and observing no loss of vacuum within the sampling interface system. Repair any leaks prior to use.
  - Record the leak check date and time on the field sampling log.
  - Close valves #1, #2, and #3, and turn off the vacuum pump before proceeding to the system purge.
- **System Purge:** With demonstration of a leakfree sampling system, a purge of the soil gas probe and sampling interface is required.
  - With all valves in the closed position, turn on the vacuum pump.
  - Open the purge valve (valve #3) and slowly open the gas probe valve (valve #1) to achieve the desired purge flow rate. Purging is carried out by pulling soil gas through the system at a rate of 100 to 200 milliliters /min for a period sufficient to achieve a purge volume that equals at least three dead volumes (internal volume of gas probe + sampling interface system).
  - Once the system has been purged, close the purge valve (valve #3). Do not again open it. Doing so will result in loss of the purge integrity and require repurging.
  - Record the purge date, time, purge rate, and volume on the field sampling log.
  - Immediately proceed to sampling. Little to no delay should occur between purging and sampling.

## Sampling

1. The Summa canister is evacuated to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. *Never open the valve affixed to the canister unless the intent is to collect sample.*
2. With the sampling system valves set as follows, a sample can be taken:
  - The purge valve (valve #3) is confirmed to be closed



- The gas probe valve open (valve #1) is open
  - The sample valve is (valve #2) is open
- 3. Slowly open the valve affixed to the canister about one full turn. You should hear a faint hissing noise as the canister fills.
- 4. The canister should take about 4 to 5 minutes fill. Close the sample valve (valve #2) and the valve affixed to the canister. Remove the canister from the apparatus.
- 5. Record the sampling date, time, canister ID, flow controller ID, and any other observation pertinent to the sampling event on the field sampling log.
- 6. Fill out all appropriate documentation (sampling forms, sample labels, chain-of-custody form, sample tags, etc.).

## **Attachments**

None.

## **Reference**

None.

## **Key Checks and Items**

- Verify all equipment is in working condition.
- Confirm flow rate for Summa canister before sampling.